West Fork Chattooga River Watershed Survey

- Habitat and Fish Summary for Spring 1993 -

Southern Research Station
Coldwater Fisheries Research Unit
and
Center for Aquatic Technology Transfer

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United States Department of Agriculture Forest Service
Southern Research Station - Coldwater Fisheries Unit

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Prepared by

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Forward

This report contains a summary of basinwide fish habitat and fish population surveys conducted in the West Fork Chattooga watershed during the Spring 1993. It is the first major product resulting from a five year study designed to investigate trout production in selected Appalachian stream basins. Habitat surveys were conducted in Spring 1989 and 1993, and fish surveys were conducted every Spring and Fall between 1989 and 1993. This report will be updated periodically as information collected during previous years and seasons is analyzed and incorporated. We thank our cooperators, the US Forest Service-National Forest System, National Park Service - Great Smoky Mountains National Park, Virginia Polytechnic Institute and State University, Clemson University, North Carolina Wildlife Resources Commission, Georgia and South Carolina Departments of Natural Resources, the Tennessee Wildlife Resources Agency, and the Chattooga and Rabun Chapters of Trout Unlimited, whose enthusiastic participation and patience over the years made this study possible.

Background

Self-sustaining populations of wild trout have high recreational and aesthetic value in the mountainous regions of the southeastern United States. To meet the high angler demand for wild trout, many streams in the states of Georgia, North Carolina, South Carolina, Tennessee, and Virginia are managed to support populations of one or more of the three salmonid species, rainbow trout *Oncorhynchus mykiss*, brown trout *Salmo trutta*, and brook trout *Salvelinus fontinalis* without artificial stocking. Other streams are stocked either to supplement low natural production of harvestable size trout or, where habitat conditions during some part of the year are inadequate for trout, to provide a seasonal (typically spring and fall) fishery.

Trout populations that support stream fisheries without supplemental stocking are very appealing to budget and quality conscious resource managers. Trout hatcheries are expensive to build and maintain, and many anglers believe that hatchery fish are "inferior" compared to their wild cousins. In contrast, trout populations maintained by natural reproduction cost little and yield wild fish that many anglers prize.

Unfortunately, because of over exploitation and habitat degradation, many streams in the southeast are apparently unable to support significant populations of wild trout. Past or present human land use, in particular removal of riparian vegetation by logging, livestock grazing, and road building, have caused changes in a variety of habitat characteristics including water temperature and overall water quality, type and quantity of sediment, instream cover (especially large woody debris), and food supplies. The restoration and protection of trout habitats depends on our ability to understand and eventually manipulate these and other factors that influence trout production.

Although there have been no comprehensive, long term studies, trout production is perceived by many fishery managers to be lower in southeastern streams than in other parts of the country. Low production usually is attributed to a single factor, such as increased temperature, sedimentation, or loss of instream cover. But production may be influenced by interactions among factors or by seasonal changes in the relative importance of individual factors. Streams that support self-sustaining trout populations must meet the demands of all life history stages. Water quantity and quality (dissolved oxygen, pH, temperature, etc.), habitat, and food must be both within the acceptable range and available at the appropriate time for successful egg and embryo incubation, summer and winter juvenile rearing, adult maintenance, and spawning.

The overall purpose of this study was to investigate aspects of trout production ecology in the Southeast. The range of trout production has not been adequately documented and the relations of specific habitat features (e.g. large woody debris loading, habitat unit size and complexity, substrate composition, etc.) and biological interactions (e.g. variations in annual recruitment, competition with other fish species) to production are not well understood. We are assessing the influence on trout production of these and other factors such as annual climatic variation, season, and within-basin habitat variability by investigating the habitat use and population characteristics of trout in a cross-section of streams in Southern Appalachian watersheds.

Research sites were selected to encompass a broad range of conditions (e.g. amount of LWD, proportion of sediment in different size categories, size of habitat unit, number of non-salmonid fish species, etc.). Specific attributes (e.g. growth, production) of trout populations were measured during spring and fall in these streams. Particular emphasis was placed on identifying relationships between fish populations and features of physical habitat and on evaluating the effects of biological processes such as recruitment and effect of other fish species (potential competitors) on production estimates.

In this report we provide a summary of Spring 1993 habitat conditions, trout distribution and density, and length frequency of trout in 10 West Fork Chattooga River watershed streams in North Carolina and Georgia. Future products will include identification of specific factors that appear to control or limit salmonid production and establishment of a long term data base for estimating habitat and trout production relationships. Pertinent research findings will be published in the scientific and popular literature.

Study Area

The headwaters of the West Fork Chattooga River originate largely in the mountains of North Carolina on lands managed either by the Nantahala National Forest or private individuals. From there until its confluence with the Main Stem Chattooga River, the 130 km of first through fourth order channels traverse a patchwork of land uses including portions of Gerogia's Chattahoochee National Forest. Although land management along the West Fork Chattooga River is influenced by a variety of both public and private interests, most of the public land surrounding the West Fork Chattooga is now included within the boundaries of the Chattooga Wild and Scenic River corridor.

The pattern of historical land use in the Chattooga drainage is similar to that for much of the southern Appalachian Mountains. Land clearing and logging of the rugged, mountainous terrain did not begin until the late 1800s and involved both overland and water transportation of logs. Road building continued well into the late 1960s, and a large proportion of the coarse sand bedload in Overflow Creek, a major branch of the West Fork Chattooga River, has been attributed to road cuts in the highly erodible, mica-schist based soils (Monte Seehorn, personal communication). Present and future land use within the Wild and Scenic River corridor is limited to recreation. Other parts of the drainage in both public and private ownership (particularly in the Blue Valley area of North Carolina) will continue to be developed for personal use, timber harvest, and other commercial enterprise.

Ten streams in the West Fork Chattooga watershed were chosen for extensive sampling. The study streams were 1) Tottery Pole Creek, 2) Metcalf Branch, 3) Smith Branch, 4) Holcomb Creek, 5) Addie Branch, 6) Ammons Creek, 7) Overflow Creek, 8) East Fork Overflow Creek, 9) Abes Creek, and 10) West Fork Overflow Creek (Figure 1). One riffle-pool combination was also studied in West Fork Chattooga River (Figure 1).

Survey Techniques

Habitat Survey - For the BVET (Basinwide Visual Estimation Techniques) we identified four habitat types; pools, glides, riffles, and cascades (Dolloff et.al 1993). Each habitat unit occupied at least 3 m^2

in area; areas smaller than 3 m^2 were included with the closest adjacent habitat unit. Dominant substrate (substrate in one of nine classes covering the greatest proportion of the wetted stream bottom; Table 1) and counts of pieces of large woody debris (LWD) in each of seven size classes (Table 1) were recorded in each habitat unit sampled.

The BVET for habitat inventory consisted of two phases, estimation and verification (Hankin and Reeves 1988; Dolloff et al. 1993). During the first phase, the watershed was stratified into reaches based on natural features (e.g. change in stream order or change in gradient) or other criteria selected by the observer to ensure repeatability or to meet other specific objectives. Also during phase one, the stream was stratified by habitat types and areas and other features for each type were visually estimated. During the second phase of the BVET, we verified and calibrated our estimates of habitat characteristics through measurements made with more accurate methods on a subsample of the total habitat units.

BVET surveys started at stream confluences and progressed upstream to the end of the respective stratum. Habitat type, distance from start points, estimated area, average and maximum depths, dominant substrate, and LWD counts were recorded for every habitat unit in the stratum.

Habitat units were sequentially numbered by habitat type. Distance (to 0.1 m) to each unit was recorded as the length along the thalweg as determined by hip-chain measurement. Average and maximum depths were estimated based on multiple gauges with a depth rod marked into 5 cm increments. Areas were accurately measured with a meter tape in a subset of units (about 20% of all pools and glides, and 10% of all riffles and cascades) to account for the bias of visual estimates. Areas were calculated as the product of length and average width. Separate calibrations were calculated for pools, riffles, and cascades within each stream stratum and watershed. Estimates of habitat area and associated variances were calculated for each habitat type and stream stratum using equations found in Dolloff et al. (1993).

Fish Survey - The BVET for fish population census also consisted of two phases, estimation and verification (Hankin and Reeves 1988; Dolloff et al. 1993). During the first phase, underwater observations were made by divers equipped with face-masks and snorkels. Divers entered habitat units (selected during phase two of the habitat survey - 20% of all pools and glides, and 10% of all riffles and cascades) and proceeded slowly upstream identifying and counting all trout and other fish species.

During the second phase of the fish survey we used multipass deletions with 700 volt AC backpack electrofishing equipment to verify and calibrate the diver counts. About 10% of phase one fish sampling units (one of every 10 habitat units searched by divers) were selected systematically for multipass depletions. Diver counts of fish in each habitat type were corrected by calibration ratios: number observed by divers\ depletion estimates. Estimates of total fish abundance and associated variances were calculated for each salmonid species using equations found in Dolloff et al. (1993). All fish captured during the two- or three-pass depletions were identified, weighed (g), measured (mm), and returned to the approximate location of capture.

Results

Habitat Survey - Total area of each habitat type was estimated for each of the Spring 1993 study streams using correction factors ($\hat{Q}$) that ranged from 0.8 to 1.1 (Table 2). Pool-like habitat (pools and glides) constituted the greatest proportion of the total surface area in all study streams (Table 2).

In general, pools were deeper than all other habitat types and glides deeper than riffles and cascades. Depth in all habitat types, however, was highly variable (Appendix D-[1-10]).

Sand was the dominant substratum in the pools and glides of 80% and 60% of the stream surveyed. Substrate in cascades was primarily bedrock and in riffles cobble (Appendix E-[1-10]).

Most of the LWD consisted of pieces < 10cm in diameter. Only Holcomb Creek, Addie Branch, Ammons Creek, and Overflow Creek showed considerable LWD loading of pieces in the larger size classes (Appendix F-[1-10]).

Fish Survey - The trout community in the West Fork Chattooga watershed was composed of brown trout, rainbow trout, and brook trout which were observed in 36%, 73%, and 55% of the streams surveyed, respectively. Brook trout were most frequent in the upper sections of the study streams. Brook trout were sympatric with brown trout in only two streams, East and West Fork Overflow Creeks, but sympatric with rainbow trout in five streams. Apparently, only Smith Branch contains an allopatric brook trout population. Only one rainbow trout and one brown trout were captured in the West Fork Chattooga River sample.

In general, trout numbers were relatively low in the West Fork Chattooga watershed in Spring 1993 (Table 3). Thus, there were often too few trout observed and captured, either by species or by habitat type, to produce reliable estimates (Table 3). We also estimated trout density whenever possible. Because of the extreme variation in trout abundance, however, all of these estimates should be viewed as indices rather than true densities. Trout densities (number per 100 m^2) at the river reach level (estimated total fish abundance/estimated total habitat area X 100) ranged from 0 to 2.5/ 100 m^2 for brown trout, 0 to 2.3/ 100 m^2 for rainbow trout, and 0 to 1.5/ 100 m^2 for brook trout (Table 3). Summaries of the fish surveys are presented in Appendices to this report.

Eleven non-salmonid species were also observed during Spring 1993; seven of which were captured in West Fork Chattooga River. Species (other than trout) and approximate ranges are given in Table 4. More complete summaries of population characteristics and distribution of non-salmonid fish will be included in a future report.

User's Guide for Appendix

Stream summaries are organized by sub-basin: downstream to upstream. Appendix numbers correspond with stream numbers given in Figure 1. Each stream summary contains seven graphs, respectively:

Appendix A. Length frequency of all trout species captured during electrofishing surveys.

Appendix B. Distribution and relative abundance (number / 100 m^2) of all trout by species in each stream. Densities are based on diver counts. Habitat units where divers did not see trout are denoted by horizontal marks on the x-axis. Age 0+ fish (young-of-year) are labeled YOY.

Appendix C. Box plots of the surface area of all habitats inventoried in each stream. Visual estimates of surface area were corrected by multiplying all estimates by a calibration ratio ($\hat{Q}$ of Hankin and Reeves 1988). The box encloses the middle 50% of the observations, the capped lines below and above the box represents the 10% and 90% quantiles, respectively, and the solid line in the box represents the median.

Appendix D. Box plots of the maximum depth of all habitats inventoried in each stream. The box encloses the middle 50% of the observations, the capped lines below and above the box represents the 10% and 90% quantiles, respectively, and the solid line in the box represents the median.

Appendix E. Dominant substrate occurrence by habitat type in each stream. Bars represent frequency (percent) and dots represent cumulative percent.

Appendix F. Pieces of large woody debris per kilometer of stream by size class in each stream. Bars represent frequency (percent) and dots represent cumulative percent.

Appendix G. Distribution and total abundance of large woody debris in each stream. Distribution and abundance of LWD 5, LWD 6, and rootwads represent the largest size classes of woody debris and are most likely to remain in the stream channels and influence habitat quality.

Literature Cited

Dolloff, C. A., D. G. Hankin, and G. H. Reeves. 1993. Basinwide estimation of habitat and fish populations in streams. General Technical Report SE-83. Asheville, North Carolina: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 25 pp.

Hankin, D. G. and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences. 45: 834-844.

Figures

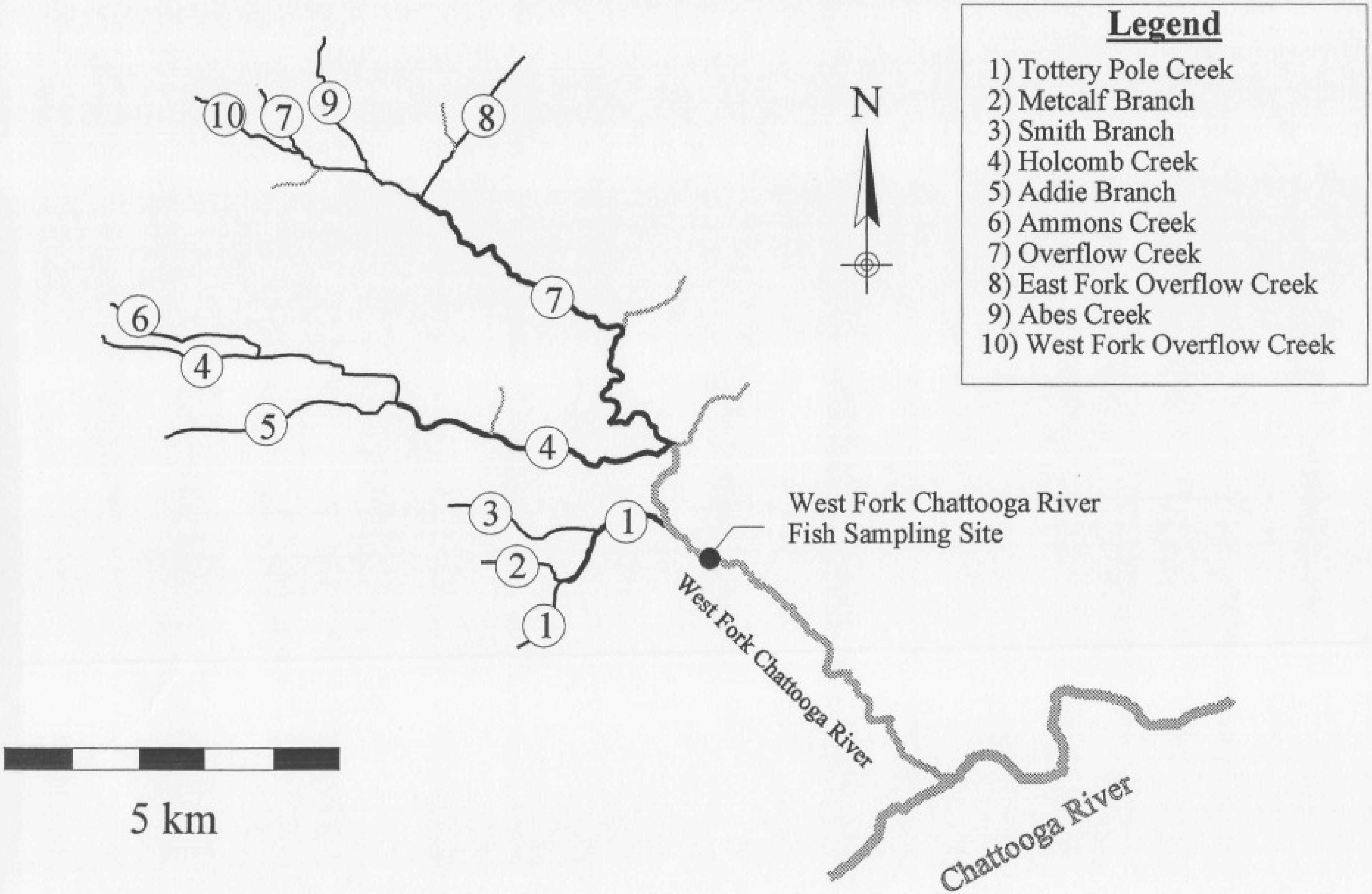


Figure 1. West Fork Chattooga watershed. Numbers represent sample streams (names given in Legend) and correspond with stream numbers given in Appendices. Streams highlighted gray were not included in this study.

Tables

Table 1. Criteria for substrate and large woody debris (LWD) classifications.

SUBSTRATE		LWD SIZE		
Class	**Diameter**	**Class**	**Length**	**Diameter**
organic debris		**1**	≥ 1; < 5 m	5-10cm
clay		**2**	≥ 1; < 5 m	10-50cm
silt		**3**	≥ 1; < 5 m	> 50cm
sand	silt- 2mm	**4**	≥ 5m	5-10cm
small gravel	2-10mm	**5**	≥ 5m	10-50cm
large gravel	1-10cm	**6**	≥ 5m	> 50cm
cobble	11-30cm	**7**	root wads	
boulder	30cm			
bedrock				

Table 2. Total number of habitat units surveyed (N), number of units measured (n), correction factor ($\hat{Q}$), estimated total habitat area ($\hat{M}$), estimated variance of the estimated total habitat area ($\hat{V}(\hat{M})$), and 95% confidence intervals (C.I.) for the estimated habitat area for West Fork Chattooga study streams. Sub-basin are given in bold font and length of stream surveyed is given parenthetically.

Stream	Type	N	n	$\hat{Q}$	$\hat{M}$	$\hat{V}(\hat{M})$	95% CI
Tottery Pole Creek	Cascade	48	5	0.9	1301.1	3081.4	±154.1
(3129.3 m)	Riffle	72	10	1.1	2893.6	146135.8	±865.4
	Pool/Glide	353	68	1.0	9691.9	96974.3	±621.5
Metcalf Branch	Cascade	41	7	1.1	1982.3	20665.4	±351.8
(1958.4 m)	Riffle	32	5	1.0	788.9	3574.0	±165.0
	Pool/Glide	183	36	1.0	5489.2	9631.4	±199.2
Smith Branch	Cascade	10	0	NA	NA	NA	NA
(811.0 m)	Riffle	31	4	0.91	872.2	3067.3	±176.2
	Pool/Glide	87	18	1.1	1635.0	8231.3	±191.4
Holcomb Creek	Cascade	43	5	1.0	2500.8	7716.0	±243.8
(8925.7 m)	Riffle	62	5	0.9	5089.8	42794.1	±574.3
	Pool/Glide	275	48	1.0	53742.3	1569053.6	±2519.8
Addie Branch	Cascade	43	4	1.0	133.3	18.8	±13.8
(2241.0 m)	Riffle	50	6	0.9	169.8	303.7	±44.8
	Pool/Glide	212	41	1.0	6669.0	56523.8	±480.5
Ammons Creek	Cascade	21	2	1.0	134.4	8.6	±37.4
(1355.7 m)	Riffle	24	3	1.1	118.4	134.0	±49.8
	Pool/Glide	93	17	0.9	4031.0	66594.6	±547.1
Overflow Creek	Cascade	37	3	0.8	859.8	21274.7	±627.6
(7900.8 m)	Riffle	56	5	1.0	2563.2	19494.8	±387.6
	Pool/Glide	270	53	1.0	67390.9	234870.2	±972.4
East Fork Overflow Creek	Cascade	58	6	1.0	2744.5	2876.3	±137.9
(4053.1 m)	Riffle	70	8	1.0	3682.4	10873.3	±246.2
	Pool/Glide	230	47	1.1	13902.3	247367.3	±1001.1
Abes Creek	Cascade	34	4	1.0	756.3	10465.8	±325.5
(1731.4 m)	Riffle	54	6	1.1	1860.8	1748.4	±107.5
	Pool/Glide	179	36	1.0	3292.4	23407.8	±310.6

20 miles

Table 2. Continued

Stream	Type	N	n	$\hat{Q}$	$\hat{M}$	$\hat{V}(\hat{M})$	95% CI
West Fork Overflow Creek	Cascade	22	2	1.0	695.0	1507.0	±493.2
(2612.3 m)	Riffle	29	3	0.8	1817.0	34619.9	±800.6
	Pool/Glide	92	19	0.9	8875.9	299455.1	±1149.7

1.6 miles

21.6 miles

Table 3. Habitat units sampled for fish in West Fork Chattooga study streams. Correction factor ($\hat{R}$), estimated total trout abundance ($\hat{Y}$), estimated variance of the total trout abundance ($\hat{V}(\hat{Y})$), 95% confidence intervals (C.I.) for the total trout abundance, and density (number/ 100 m^2). Rainbow Trout = RBT, Brown Trout = BNT, Brook Trout =BKT, not applicable = NA and *. Sub-basins are given in bold font and hipchain distance for Holcomb Creek reaches are given parenthetically .

Stream	Species	Habitat Type	Units Snorkeled	Units Shocked	$\hat{R}$	$\hat{Y}$	$\hat{V}(\hat{Y})$	95% CI	Density
Tottery Pole Creek	NA	Cascade	10	2	*	*	*	*	*
Metcalf Branch	NA	Riffle	17	8	*	*	*	*	*
Smith Branch (combined)	BKT	Pool/Glide	107	15	1.429	251.9	8558.6	± 198.4	1.5
Holcomb Creek (Lower)	NA	Cascade	1	0	*	*	*	*	*
(0 - 6027.4 m)	NA	Riffle	3	1	*	*	*	*	*
	RBT	Pool/Glide	31	3	0.667	334.5	44544.7	± 908.0	0.9
	NA	Cascade	1	0	*	*	*	*	*
	NA	Riffle	3	1	*	*	*	*	*
	BNT	Pool/Glide	31	3	3.000	929.0	81290.3	± 1226.9	2.5
Holcomb Creek (Upper)	NA	Cascade	2	1	*	*	*	*	*
(6027 - 8927.4)	NA	Riffle	3	3	*	*	*	*	*
	BKT	Pool/Glide	19	4	0.500	27.2	303.3	± 55.4	0.2
Addie Branch	NA	Cascade	0	0	*	*	*	*	*
	NA	Riffle	6	2	*	*	*	*	*
	NA	Pool/Glide	42	4	*	*	*	*	*

Table 3. Continued

Stream	Species	Type	Units Dove	Units Shocked	R̂	Ŷ	V̂(Ŷ)	95% CI	Density
Ammons Creek	NA	Cascade	2	2	*	*	*	*	*
	NA	Riffle	3	3	*	*	*	*	*
	BKT	Pool/Glide	18	3	0.200	41.3	24273.7	±670.4	1.0
Overflow Creek	NA	Cascade	0	0	*	*	*	*	*
	NA	Riffle	3	2	*	*	*	*	*
	RBT	Pool/Glide	54	4	0.964	1552.5	656792.0	±2578.8	2.3
East Fork Overflow Creek	NA	Cascade	6	4	*	*	*	*	*
	NA	Riffle	8	3	*	*	*	*	*
	BNT	Pool/Glide	45	5	1.500	46.0	55261.3	±652.6	0.3
	BKT	Cascade	6	4	2.000	19.3	377.0	±61.7	0.7
	NA	Riffle	8	3	*	*	*	*	*
	BKT	Pool/Glide	45	5	1.000	122.7	456.4	±76.3	0.9

Table 3. Continued

Stream	Species	Type	Units Dove	Units Shocked	$\hat{R}$	$\hat{Y}$	$\hat{V}(\hat{Y})$	95% CI	Density
Abes Creek	NA	Cascade	3	3	*	*	*	*	*
	NA	Riffle	6	3	*	*	*	*	*
	NA	Pool/Glide	35	4	*	*	*	*	*
West Fork Overflow Creek	BKT	Cascade	4	2	1.0	5.5	49.5	89.4	0.8
	RBT	Riffle	4	3	2.0	14.5	270.7	70.8	0.8
	BKT	Pool/Glide	18	6	1.000	25.6	63.0	20.4	0.3

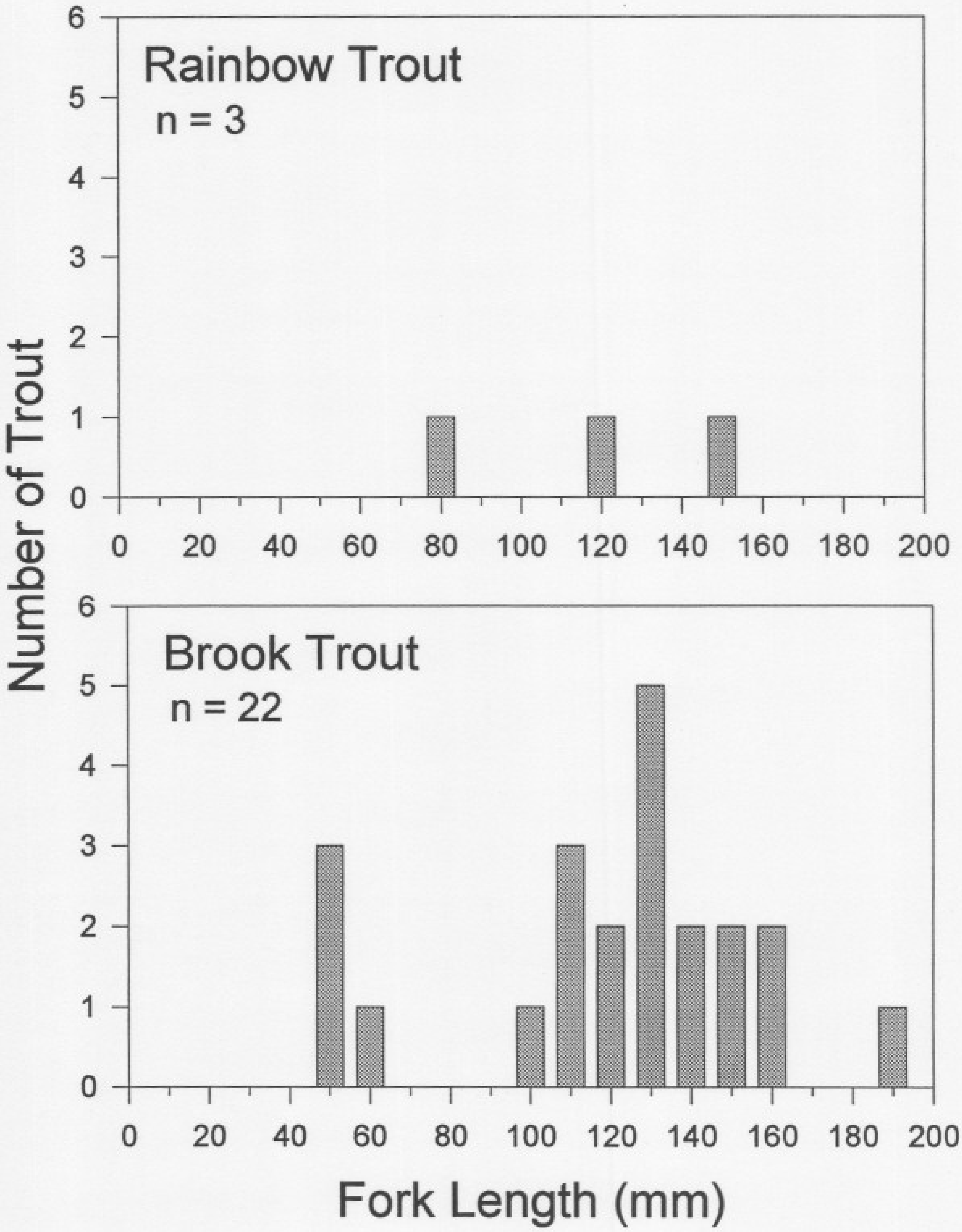
Table 4. Partial distribution of non-salmonid species in the West Fork Chattooga watershed. Distributions are based on diver observations and electrofishing surveys.

Stream	Common name	Scientific name	Stream kilometer
West Fork Chattooga River	Turquoise Darter	*Etheostoma inscriptum*	Figure 1
	Longnose Dace	*Rhinichthys cataractae*	
	Warpaint Shiner	*Luxilus coccogenis*	
	Mirror Shiner	*Notropis spectrunculus*	
	Yellowfin Shiner	*N. Lutipinnis*	
	Tennessee Shiner	*N. Leuciodus*	
	Striped Jumprock	*Moxostoma rupiscartes*	
Tottery Pole Creek	Blacknose Dace	*Rhinichthys atratulus*	0 - 0.02
	White Sucker	*Catostomus commersoni*	0 - 0.02
	Northern Hogsucker	*Hypentelium nigricans*	0 - 0.08
Overflow Creek	Blacknose Dace	*Rhinichthys atratulus*	0 - 0.35
	White Sucker	*Catostomus commersoni*	0 - 2.73
East Fork Overflow Creek	Redbreast Sunfish	*Lepomis auritus*	0 - 0.04
	Blacknose Dace	*Rhinichthys atratulus*	0 - 2.15

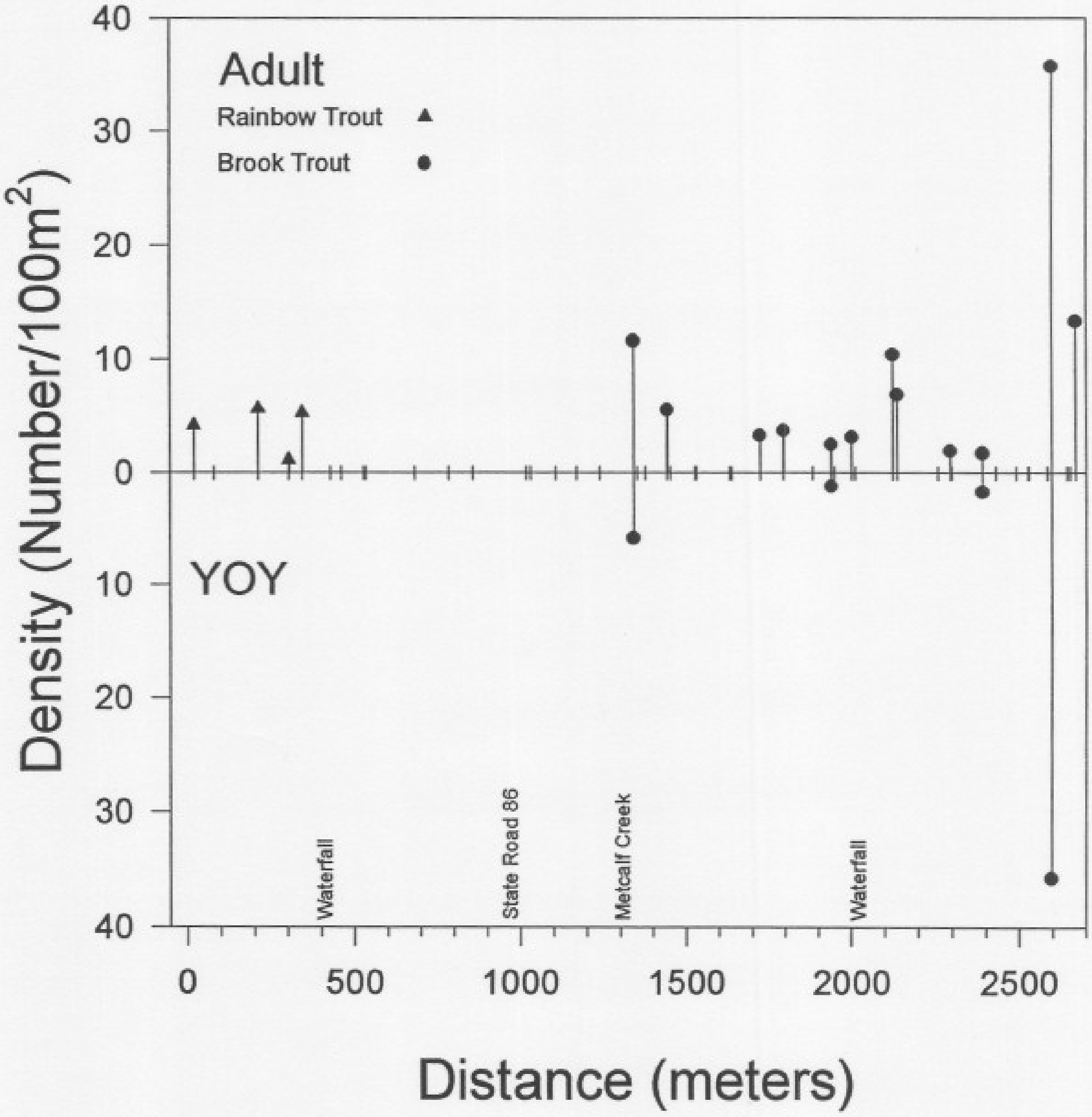
Appendix

Tottery Pole Creek Basin

Tottery Pole



Tottery Pole



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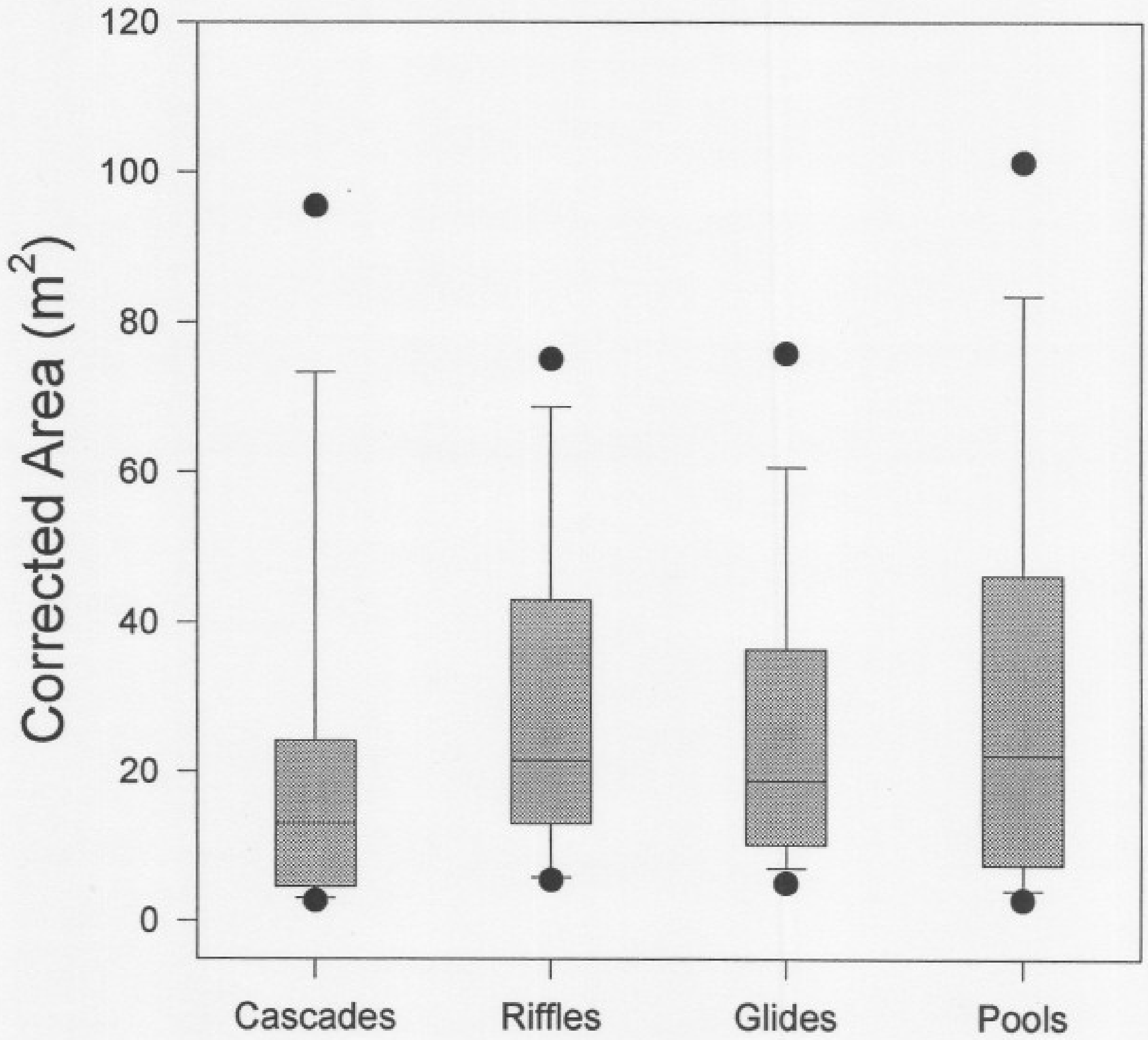
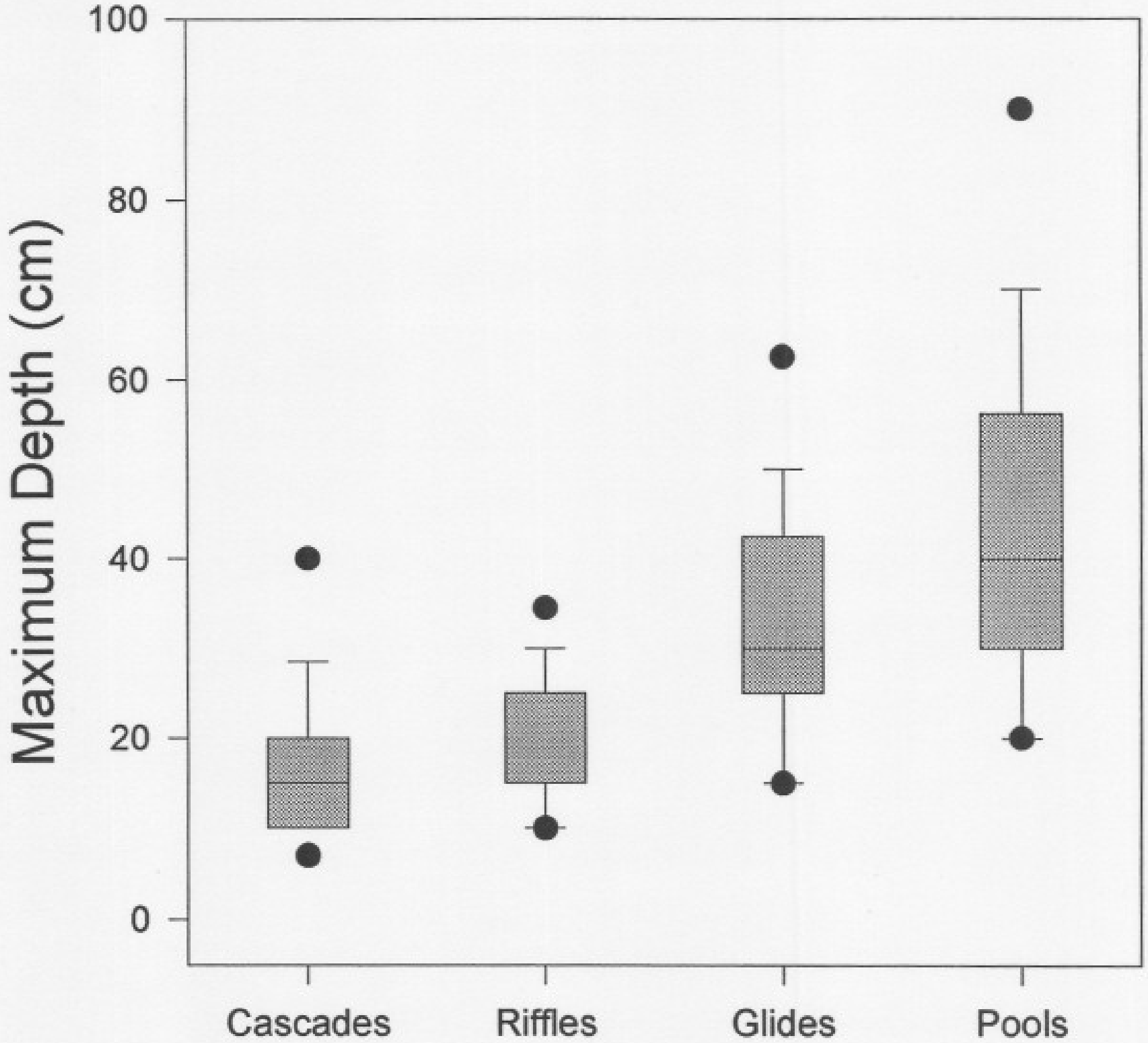


Tottery Pole



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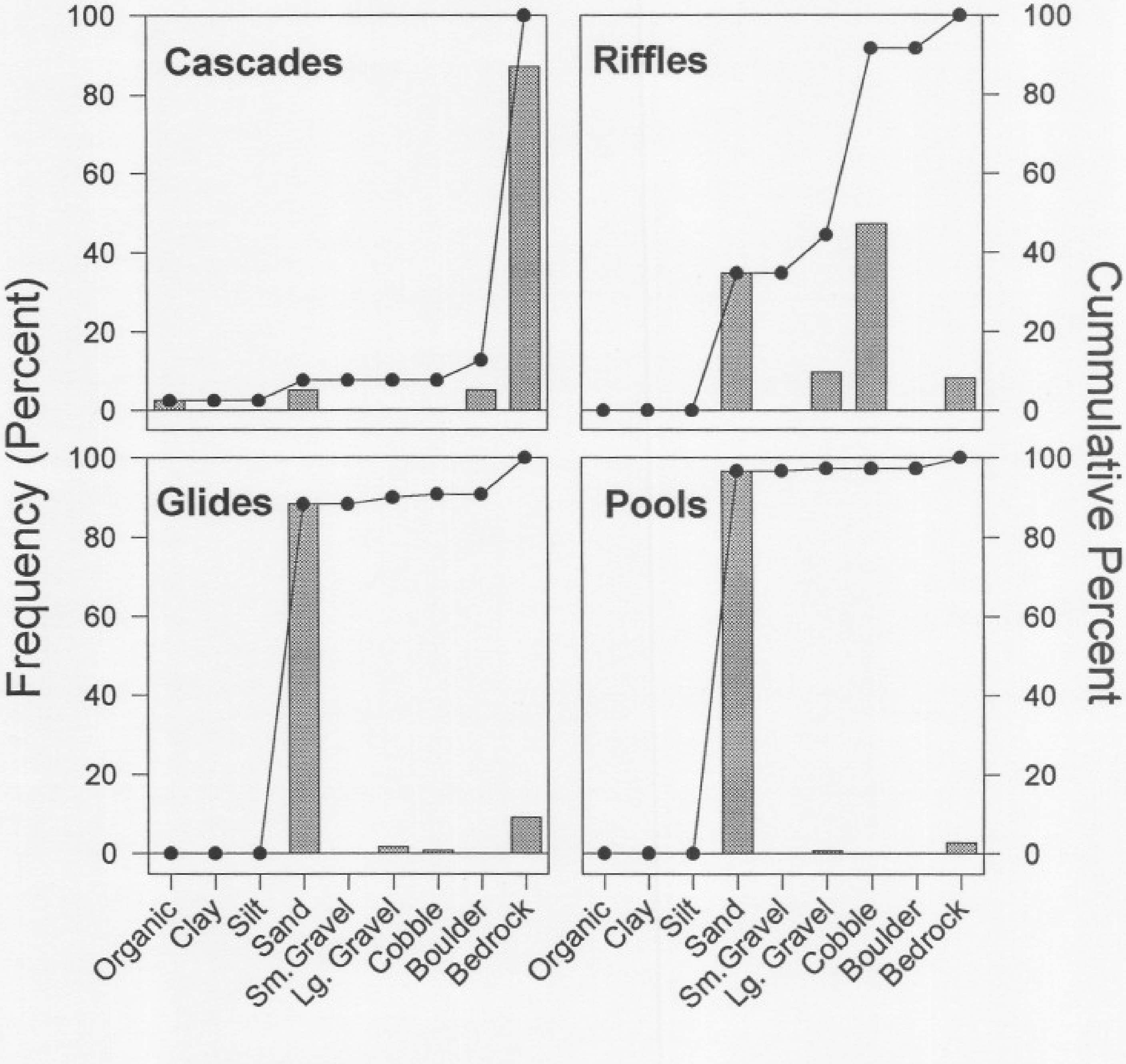
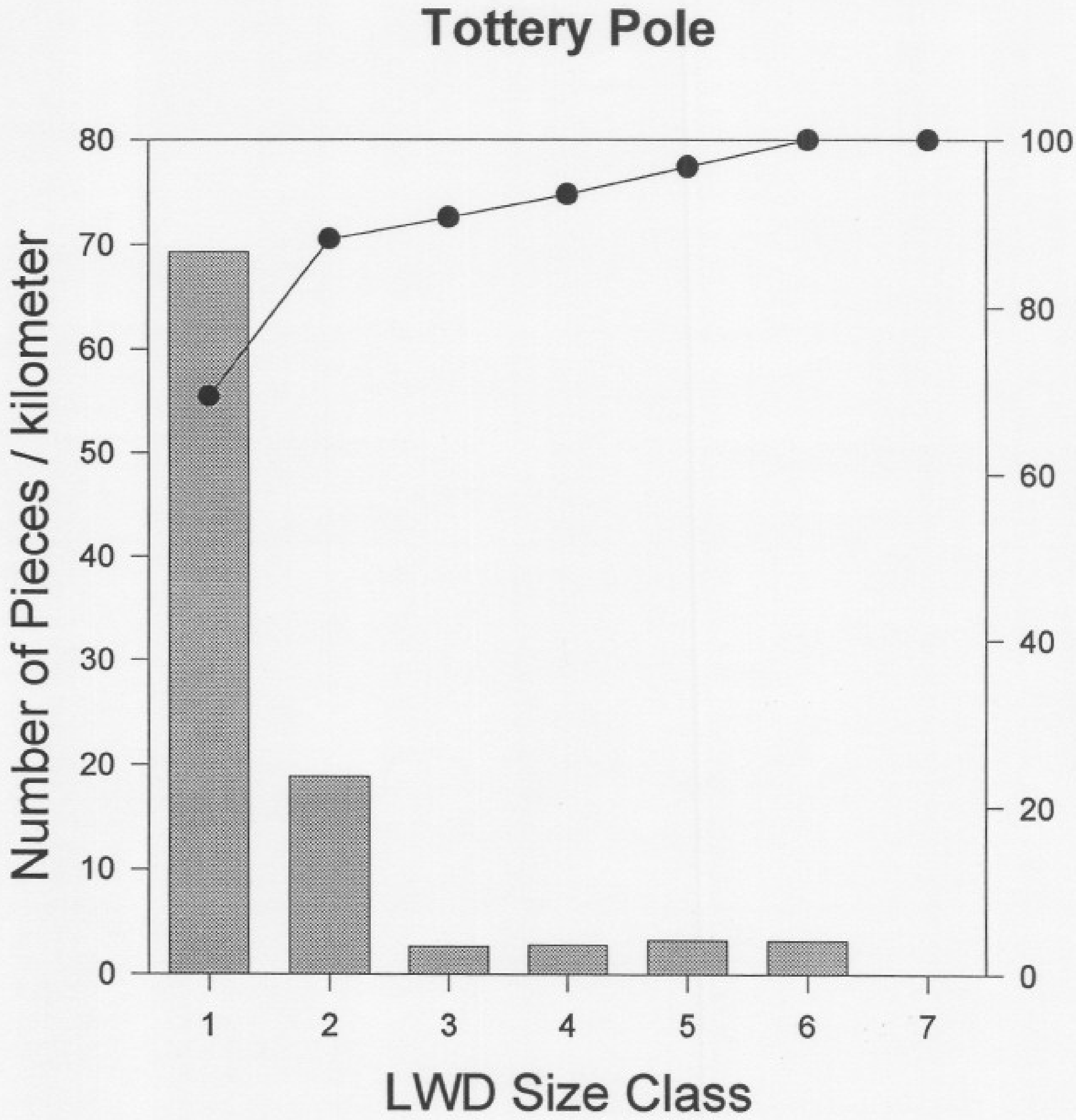
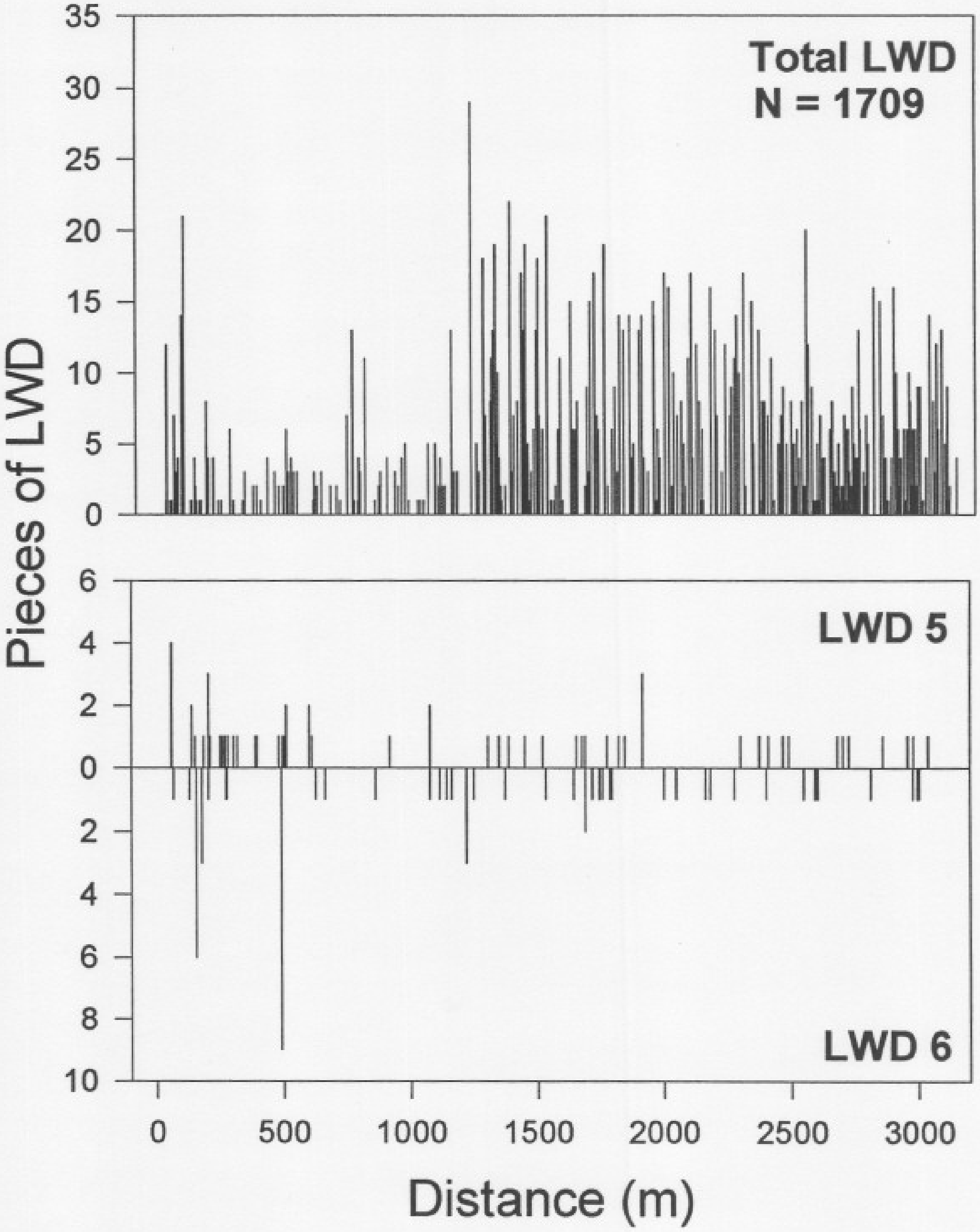


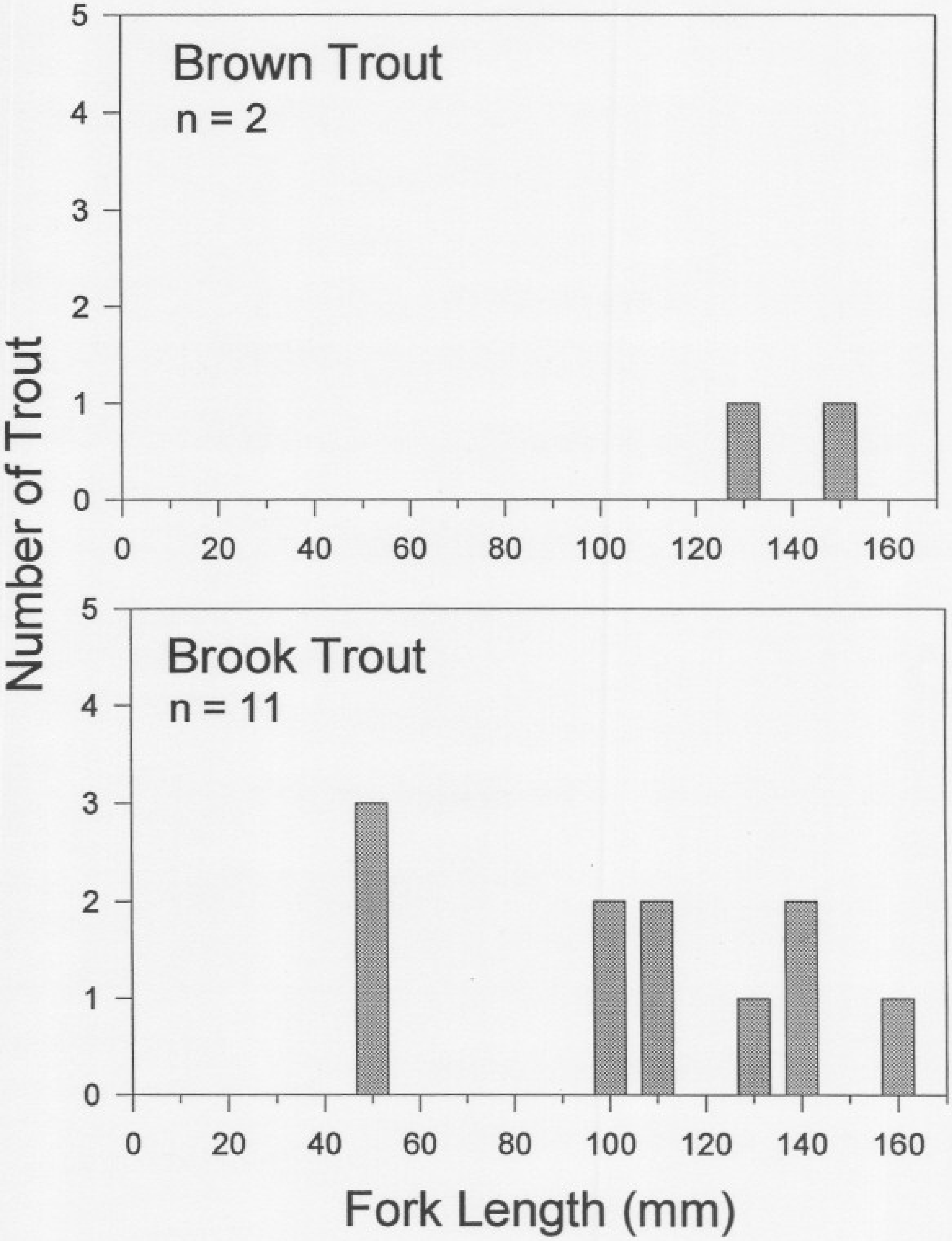


Tottery Pole
Number of Pieces / kilometer
Cummulative Percent
LWD Size Class
0
10
20
30
40
50
60
70
80
100
1
2
3
4
5
6
7

Tottery Pole

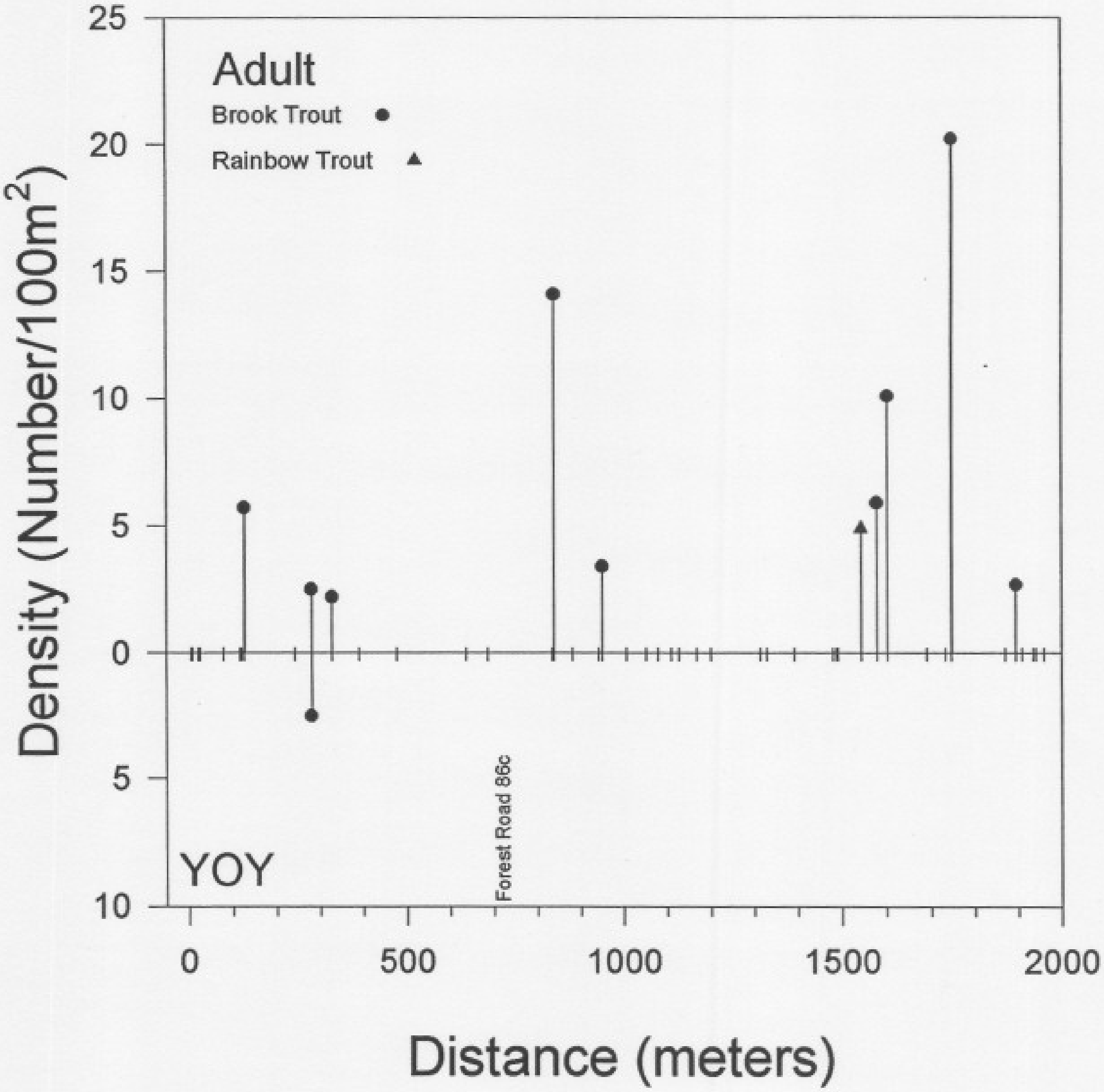


Metcalf

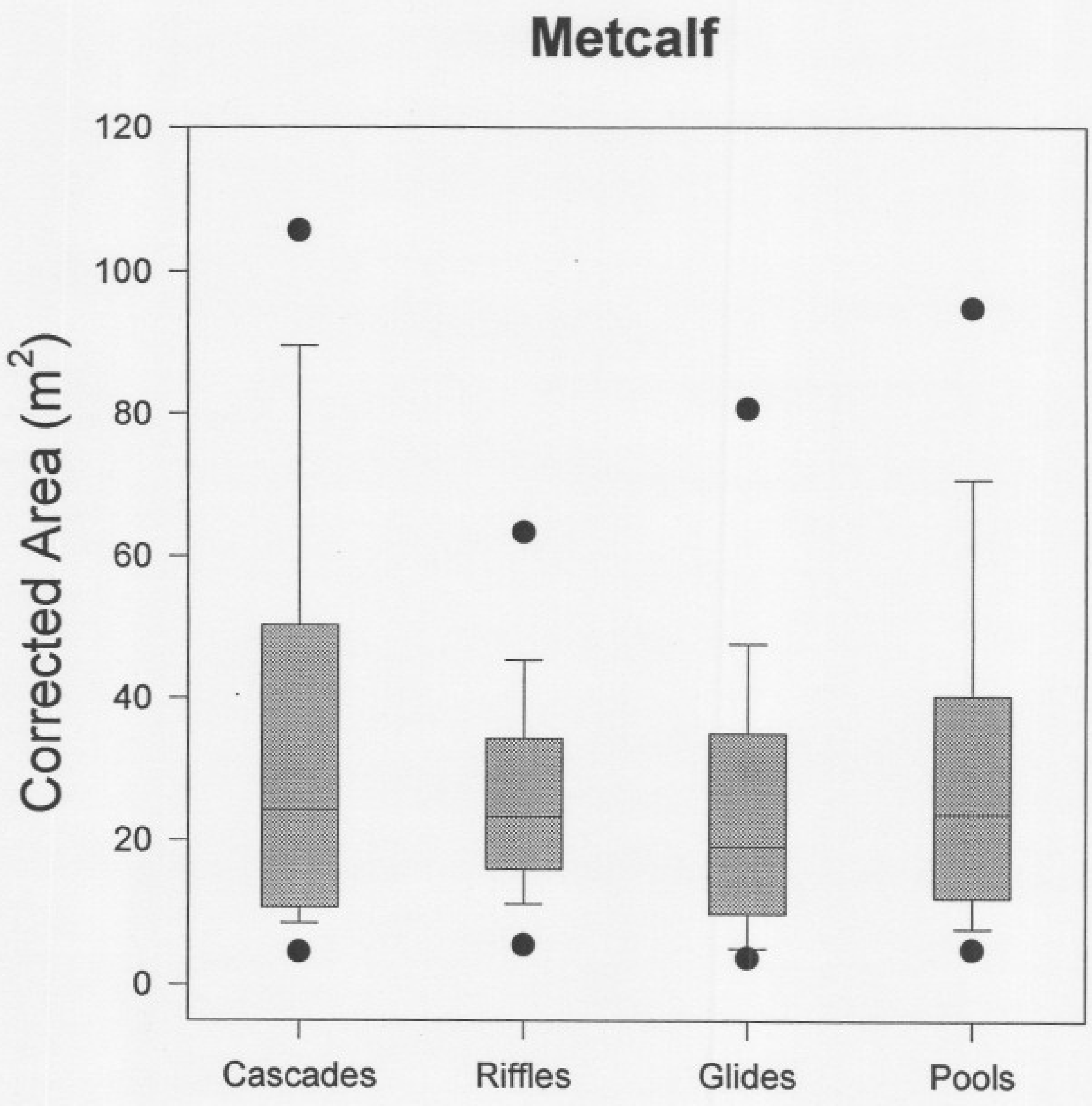


Brown Trout
n = 2
Brook Trout
n = 11
Number of Trout
Fork Length (mm)
0
1
2
3
4
5
0
20
40
60
80
100
120
140
160

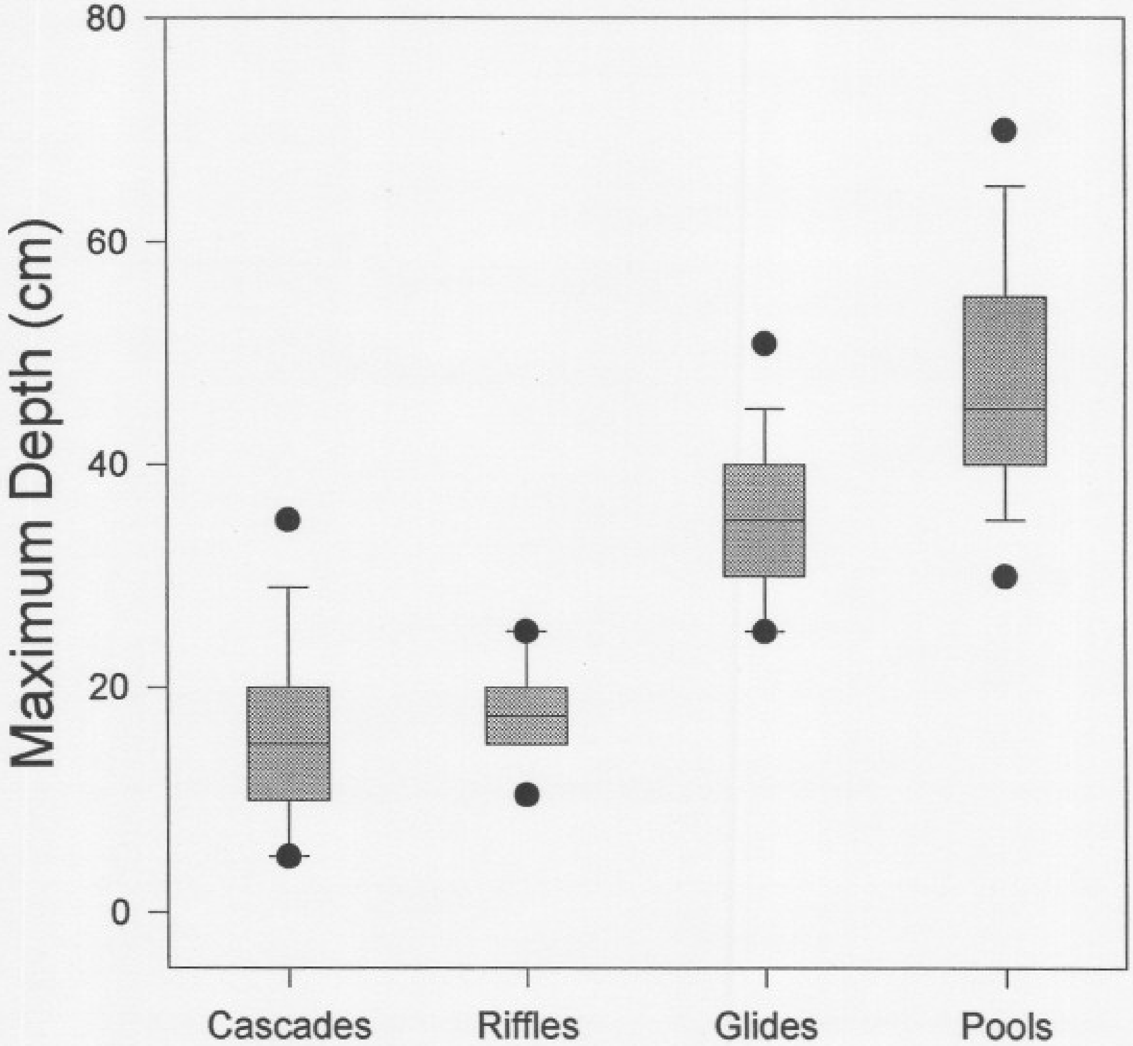
Metcalf

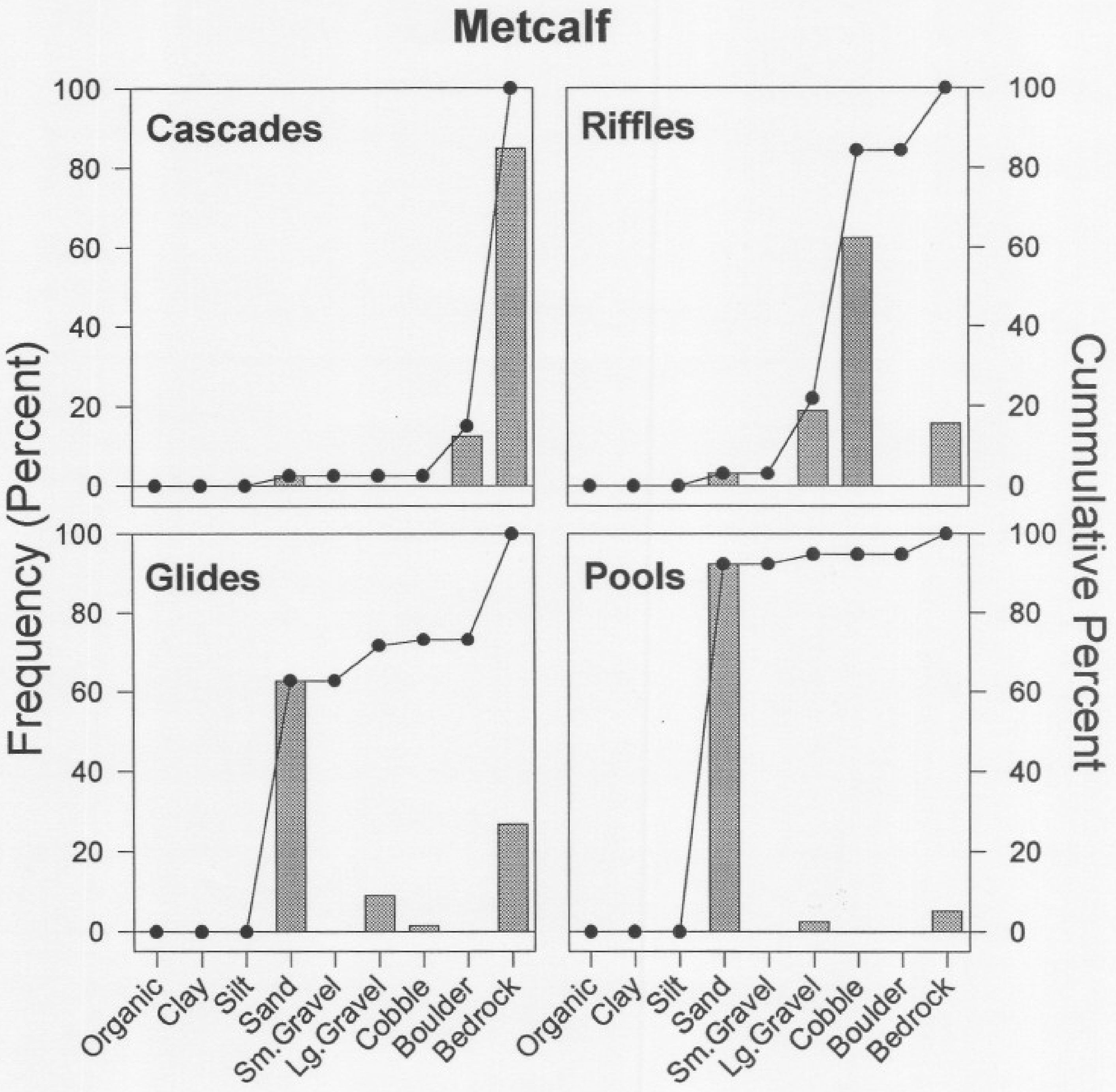


Adult
Brook Trout
Rainbow Trout
YOY
Forest Road 86c
Density (Number/100m^2)
Distance (meters)
25
20
15
10
5
0
5
10
0
500
1000
1500
2000

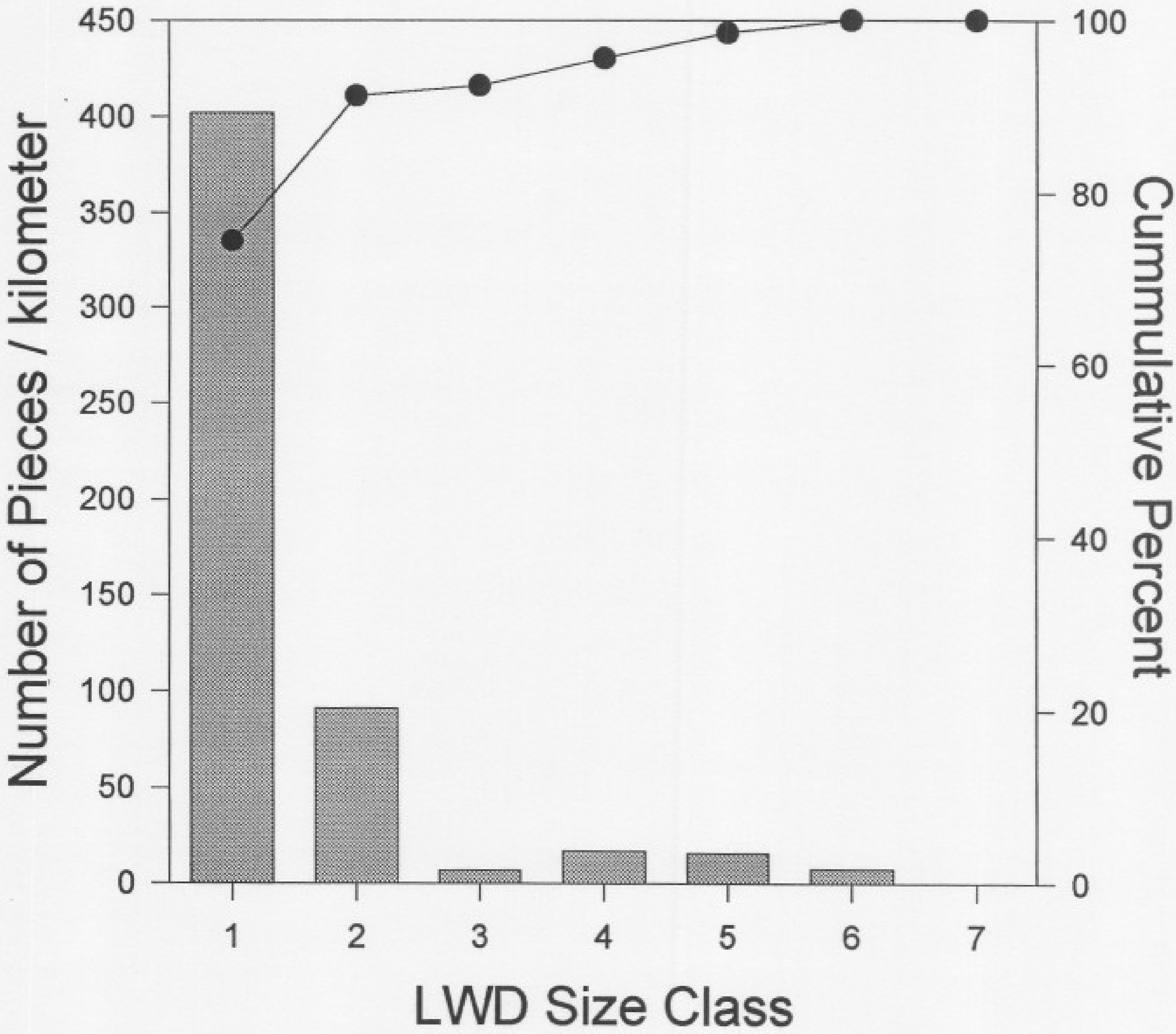

Metcalf
Corrected Area (m2)
120
100
80
60
40
20
0
Cascades
Riffles
Glides
Pools

Metcalf

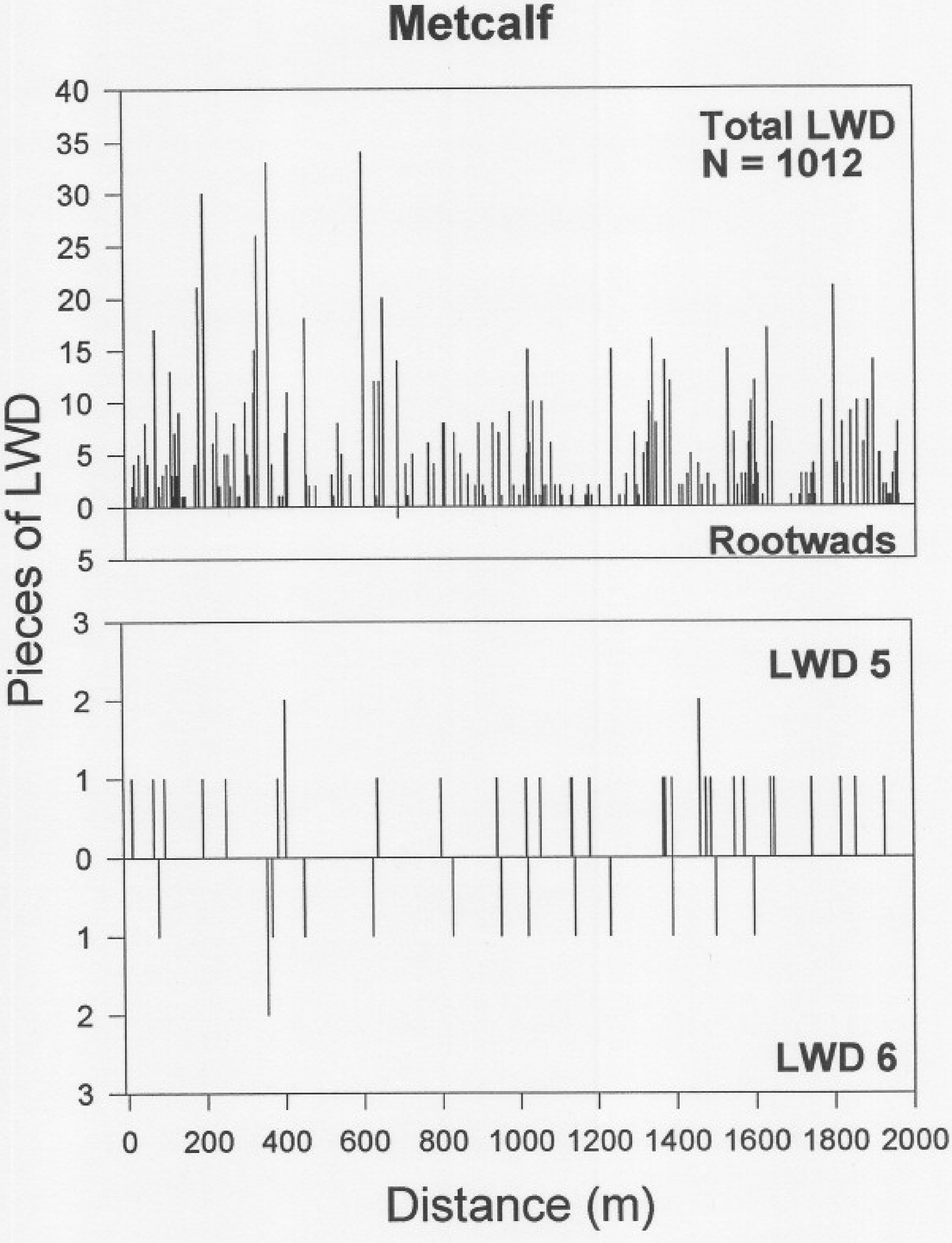



Metcalf
Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

Metcalf

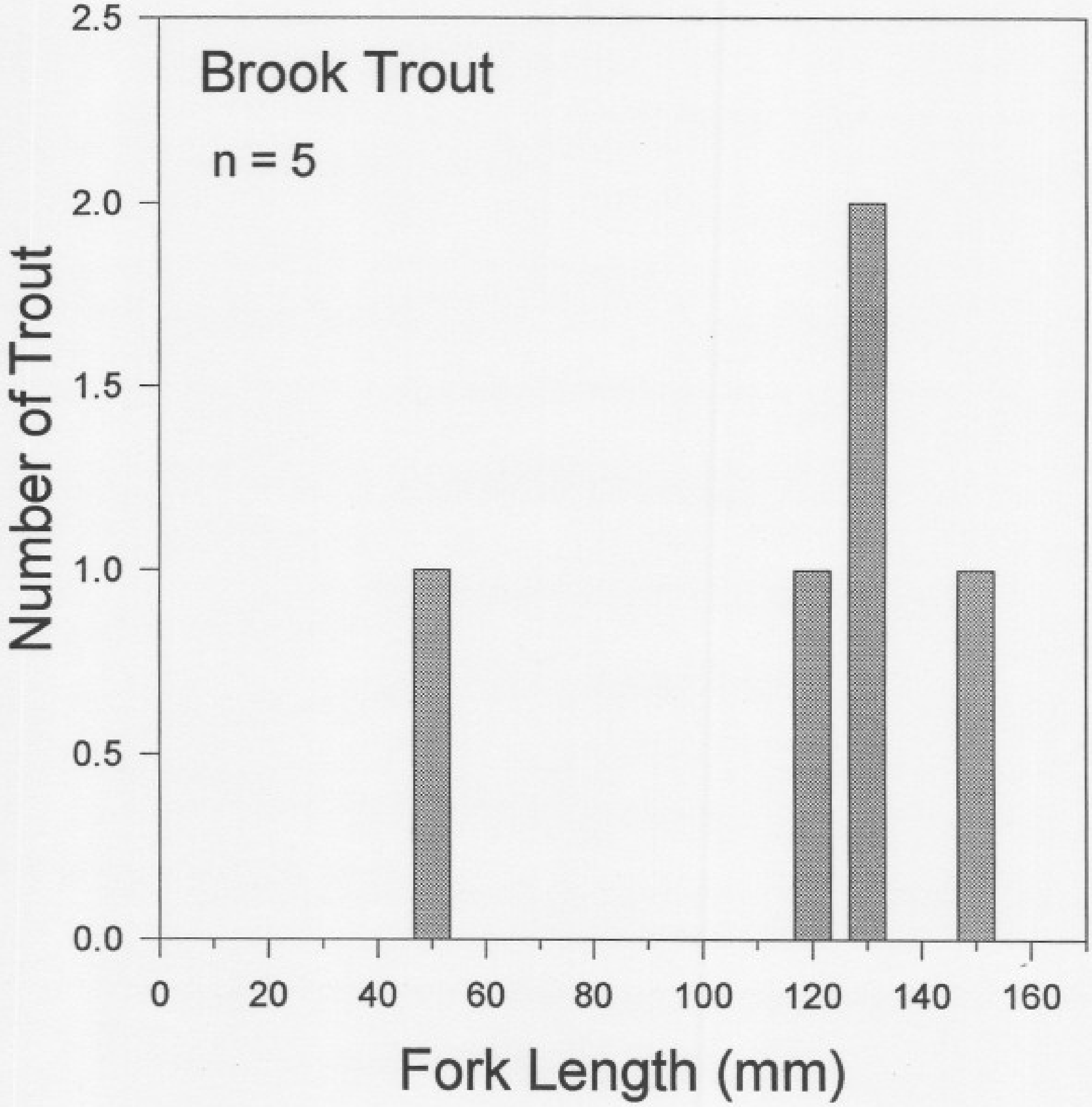


Number of Pieces / kilometer
450
400
350
300
250
200
150
100
50
0
Cummulative Percent
100
80
60
40
20
0
1
2
3
4
5
6
7
LWD Size Class



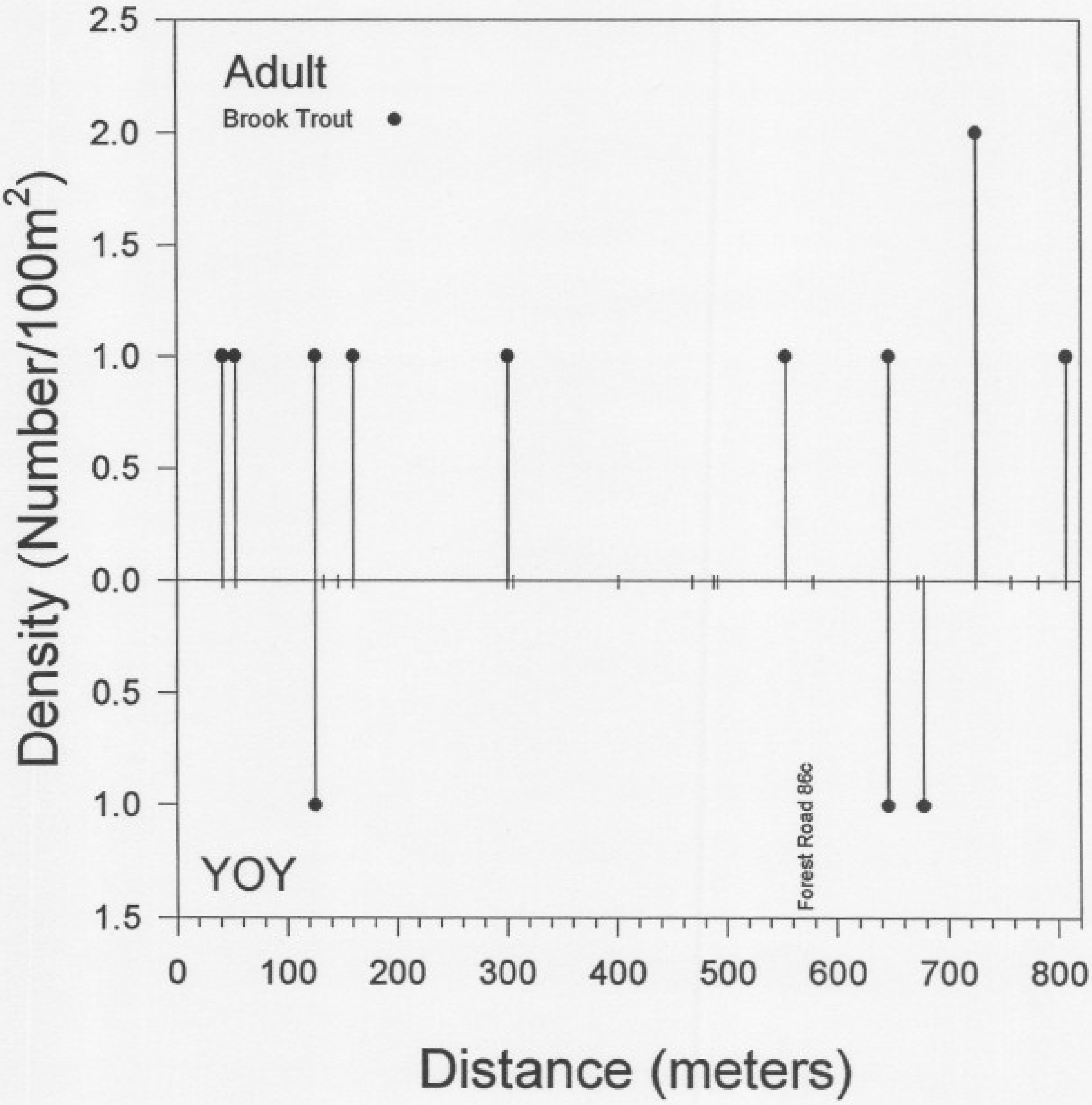
Metcalf
Total LWD
N = 1012
Rootwads
LWD 5
LWD 6
Pieces of LWD
40
35
30
25
20
15
10
5
0
5
3
2
1
0
1
2
3
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Distance (m)

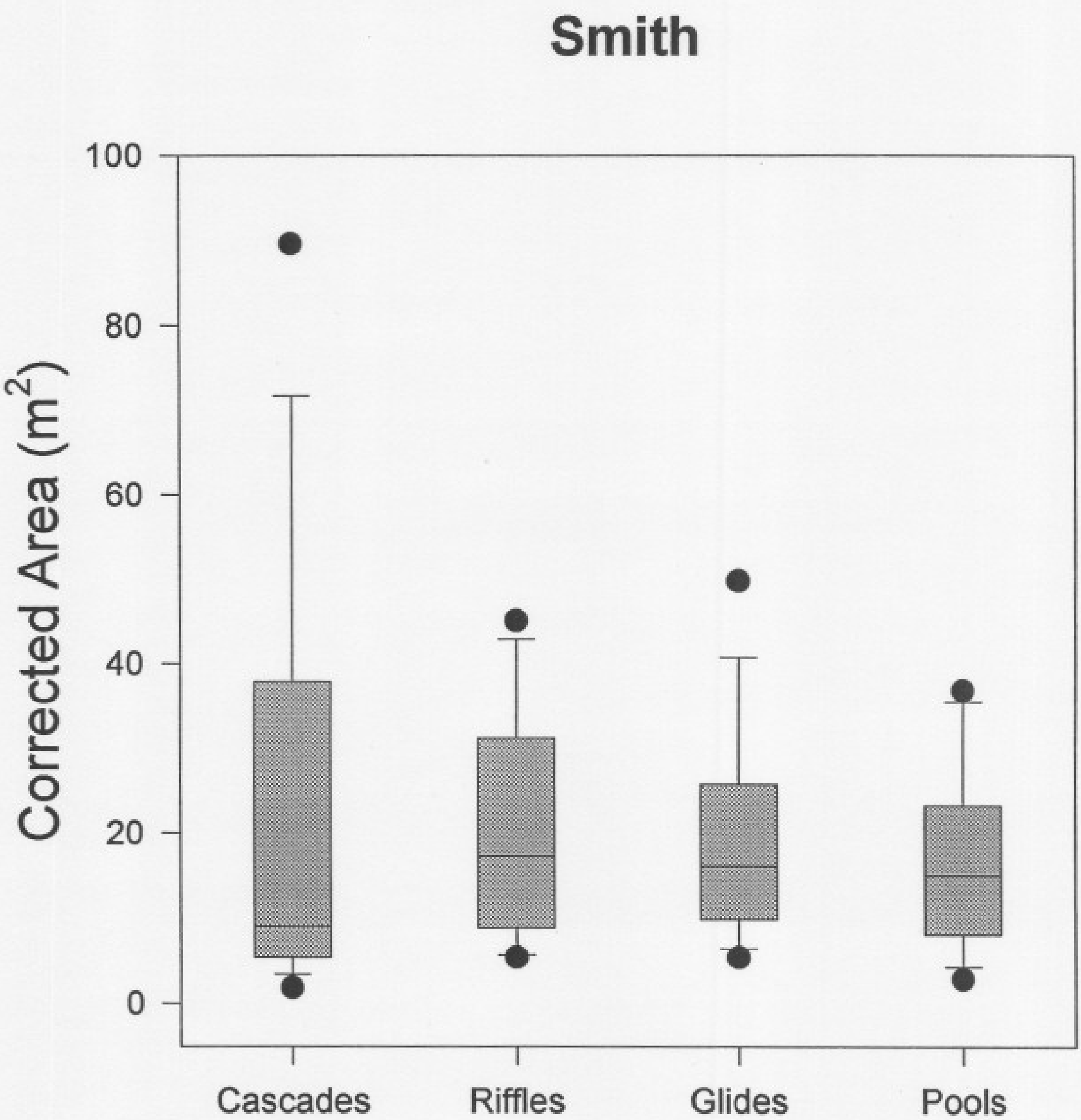
Smith



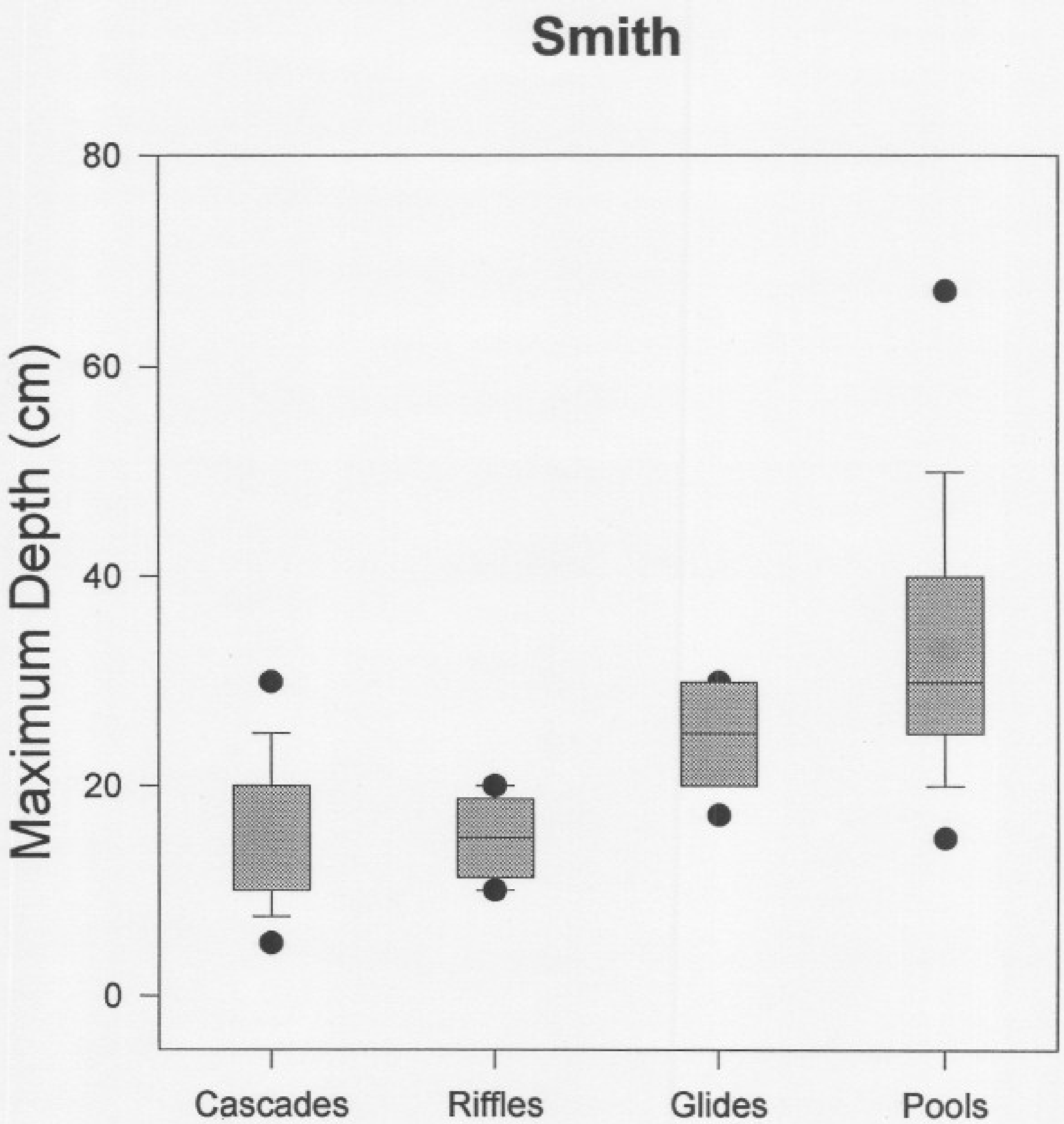
Brook Trout
n = 5
Number of Trout
2.5
2.0
1.5
1.0
0.5
0.0
0
20
40
60
80
100
120
140
160
Fork Length (mm)

Smith


2.5
2.0
1.5
1.0
0.5
0.0
0.5
1.0
1.5
Density (Number/100m2)
Adult
Brook Trout
YOY
Forest Road 86c
0
100
200
300
400
500
600
700
800
Distance (meters)

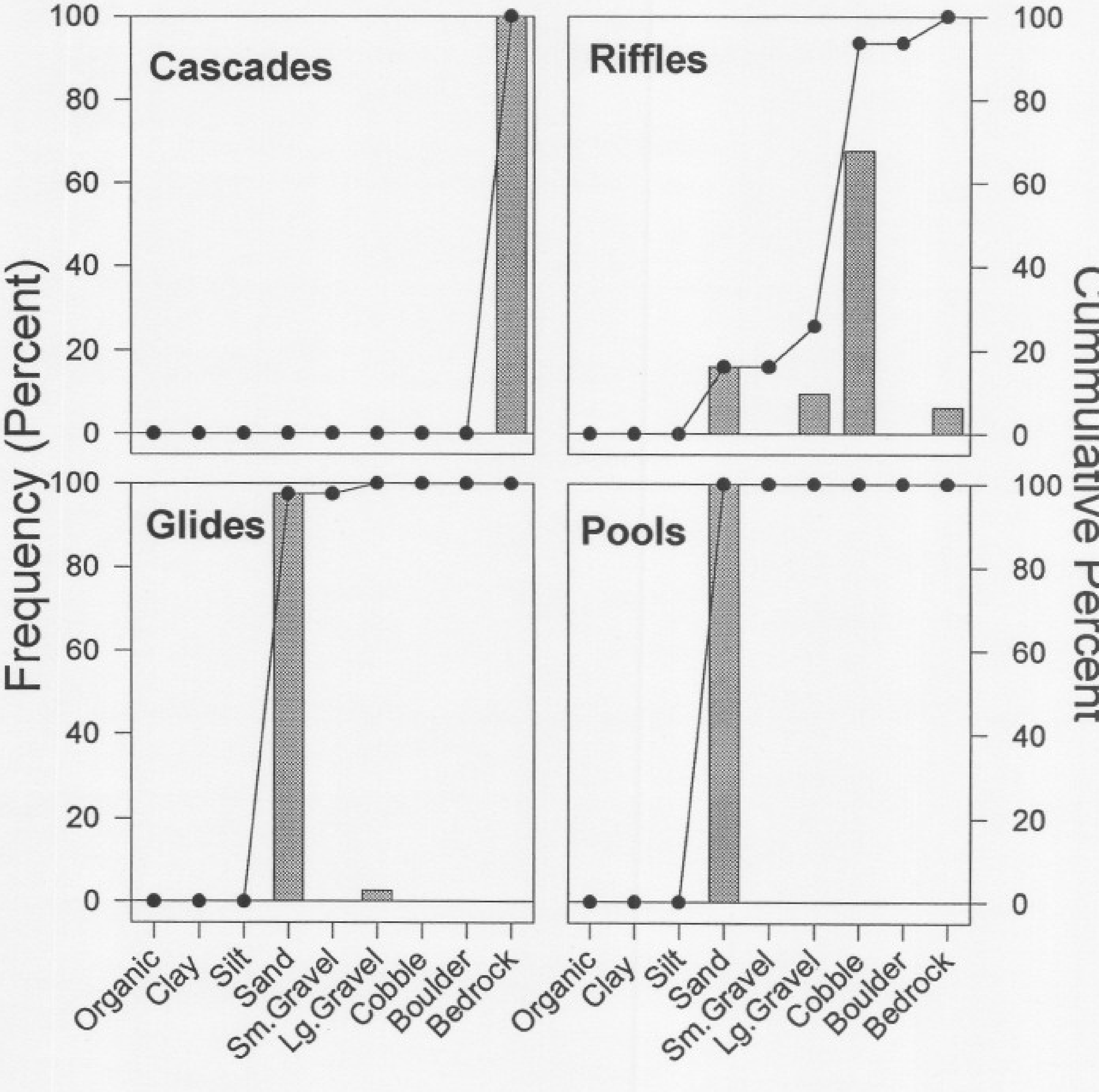

Smith
100
80
60
40
20
0
Corrected Area (m2)
Cascades
Riffles
Glides
Pools

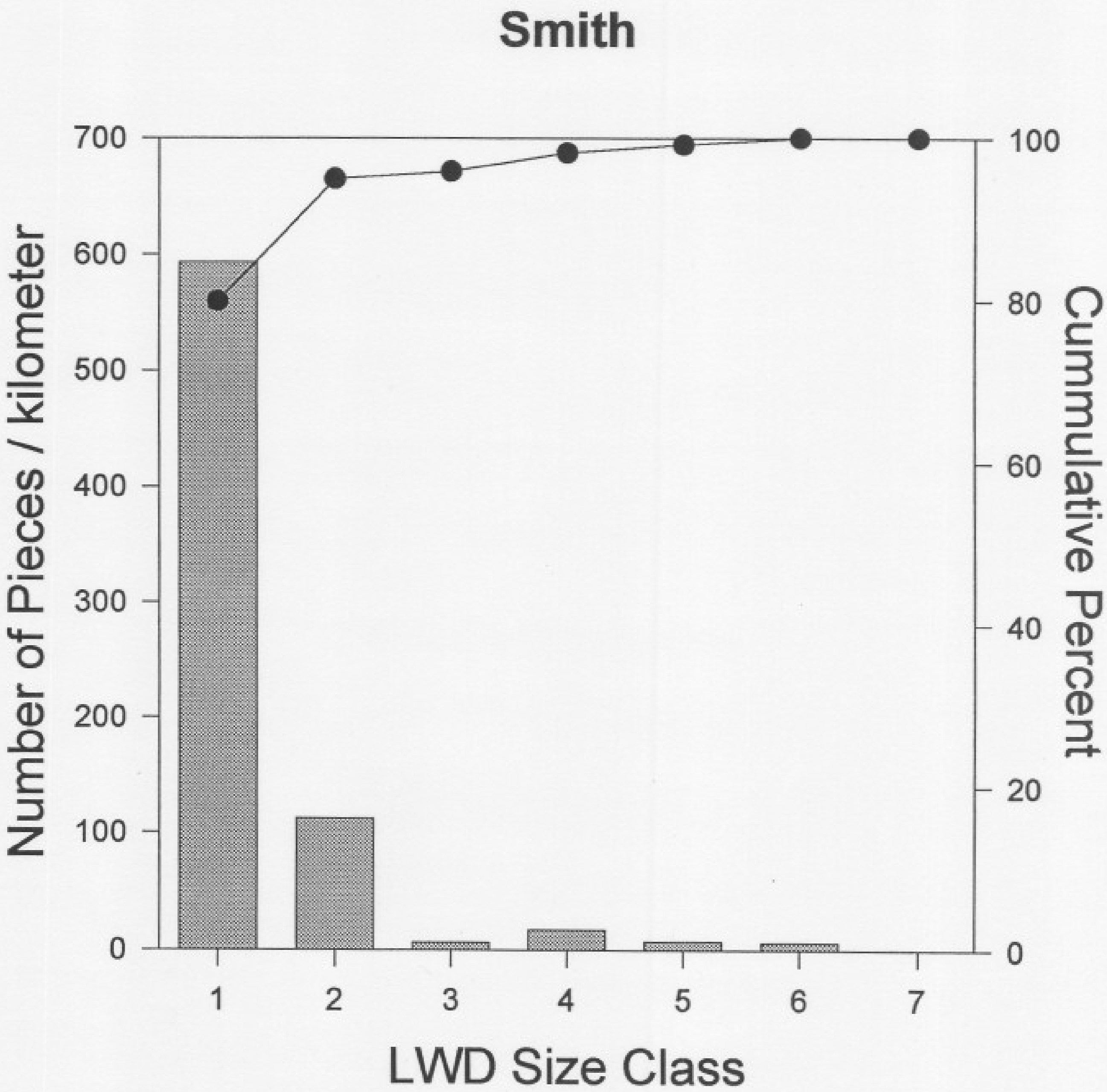
Smith



Smith
80
60
40
20
0
Maximum Depth (cm)
Cascades
Riffles
Glides
Pools

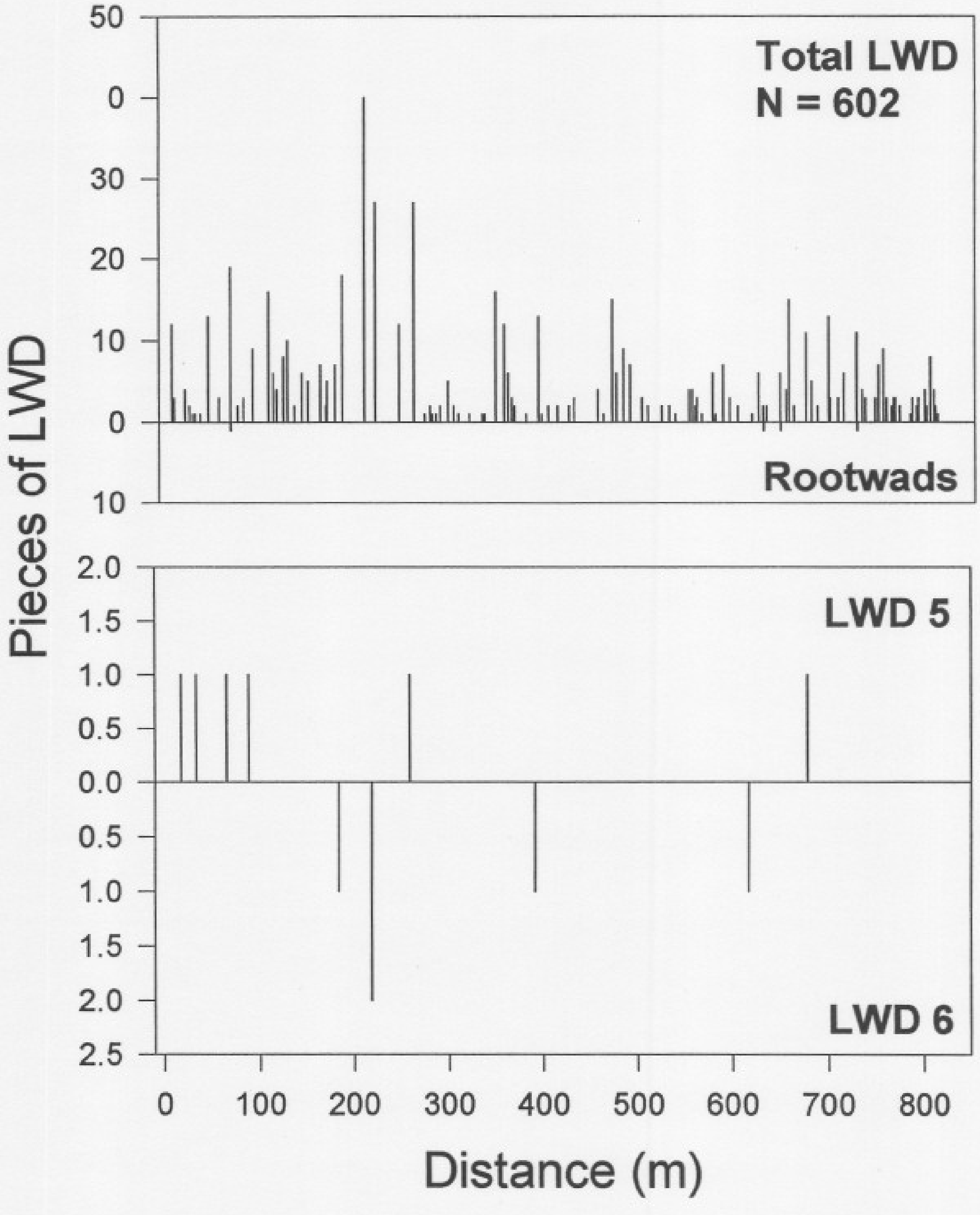
Smith


Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
100
80
60
40
20
0
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

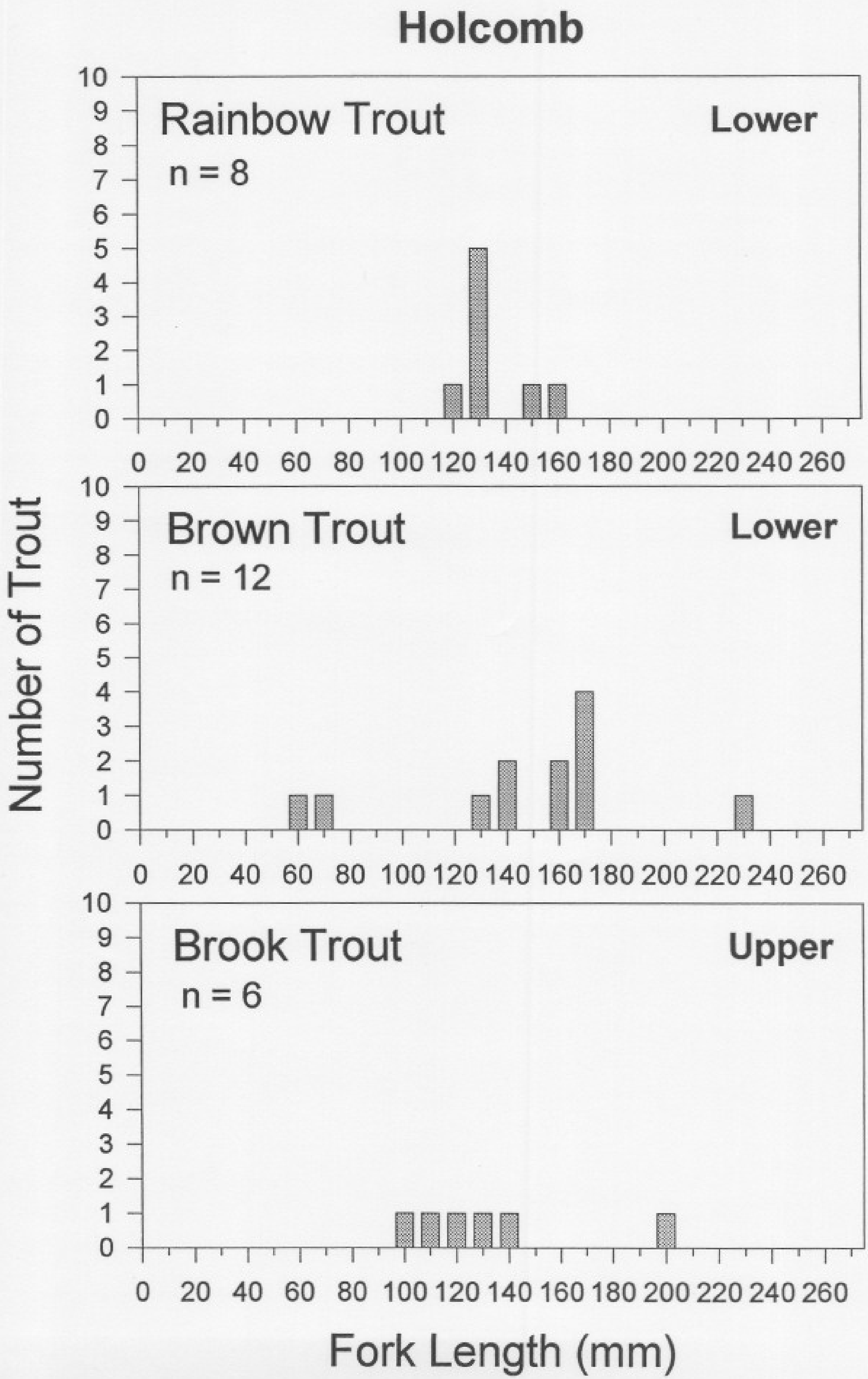


Smith
700
600
500
400
300
200
100
0
Number of Pieces / kilometer
100
80
60
40
20
0
Cummulative Percent
1
2
3
4
5
6
7
LWD Size Class

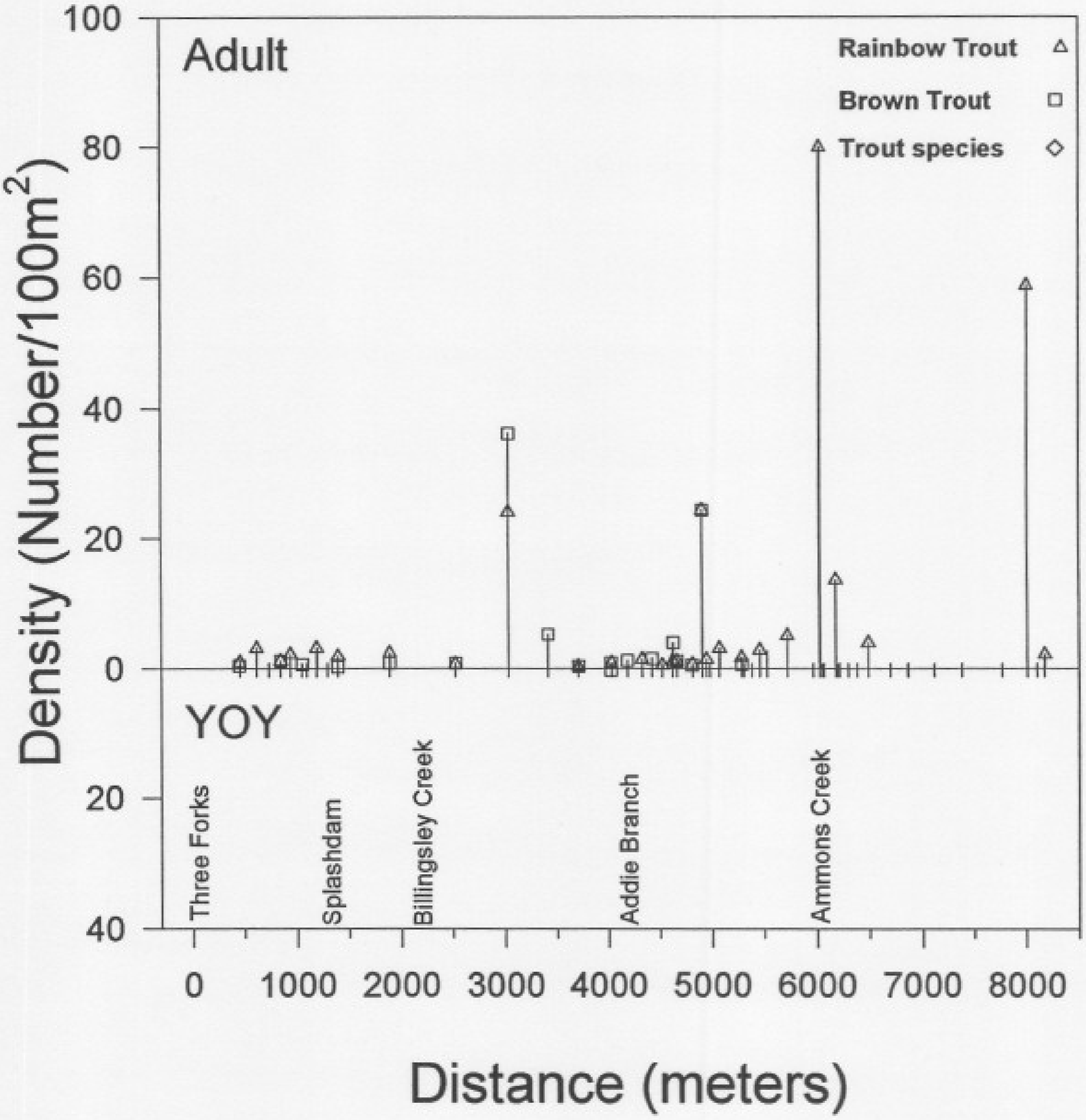
Smith


Total LWD
N = 602
Rootwads
LWD 5
LWD 6
Pieces of LWD
Distance (m)
50
0
30
20
10
0
10
2.0
1.5
1.0
0.5
0.0
0.5
1.0
1.5
2.0
2.5
0
100
200
300
400
500
600
700
800

Holcomb Creek Basin

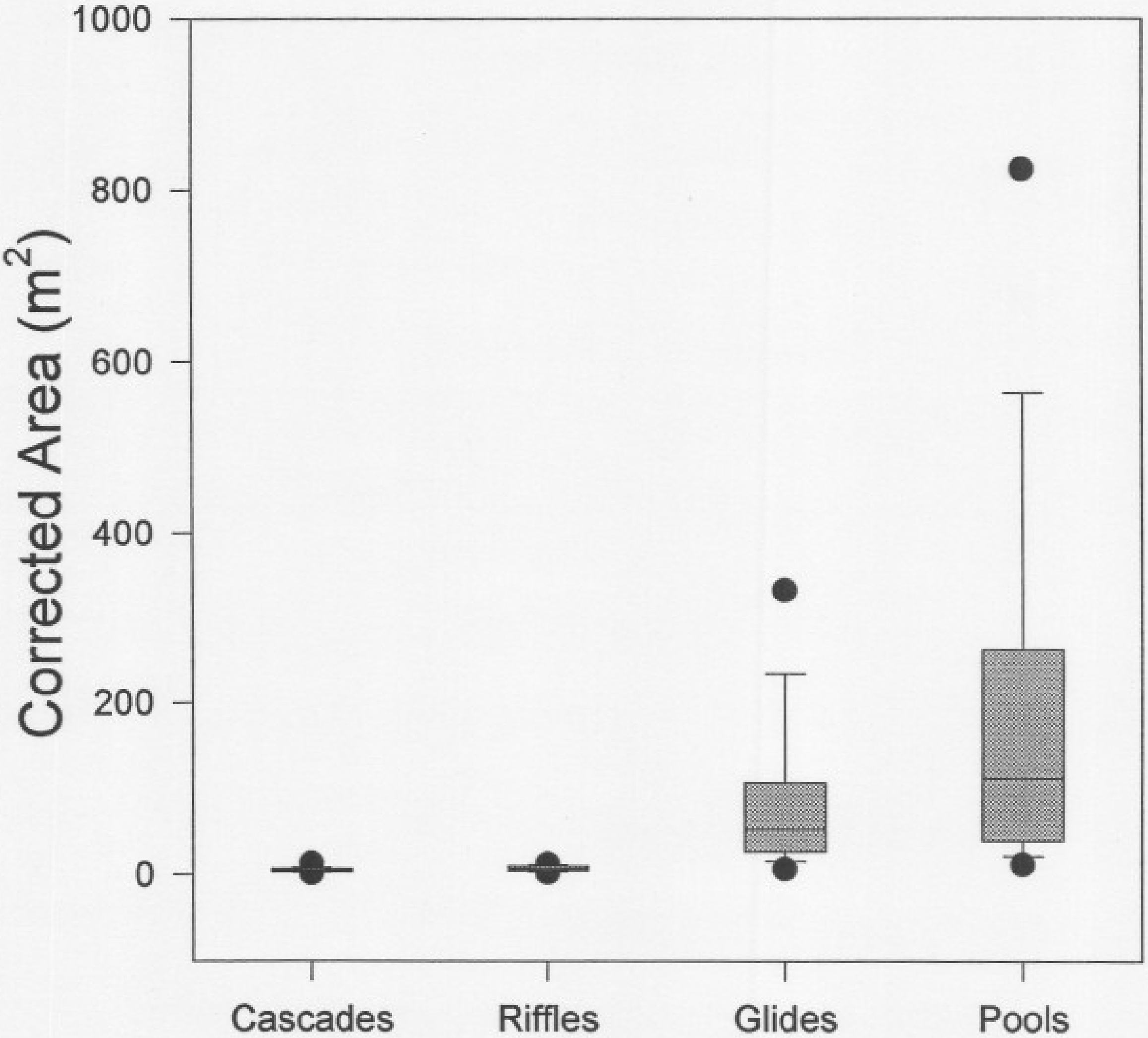

Holcomb
Rainbow Trout
n = 8
Lower
Brown Trout
n = 12
Lower
Brook Trout
n = 6
Upper
Number of Trout
Fork Length (mm)
0
1
2
3
4
5
6
7
8
9
10
0 20 40 60 80 100 120 140 160 180 200 220 240 260

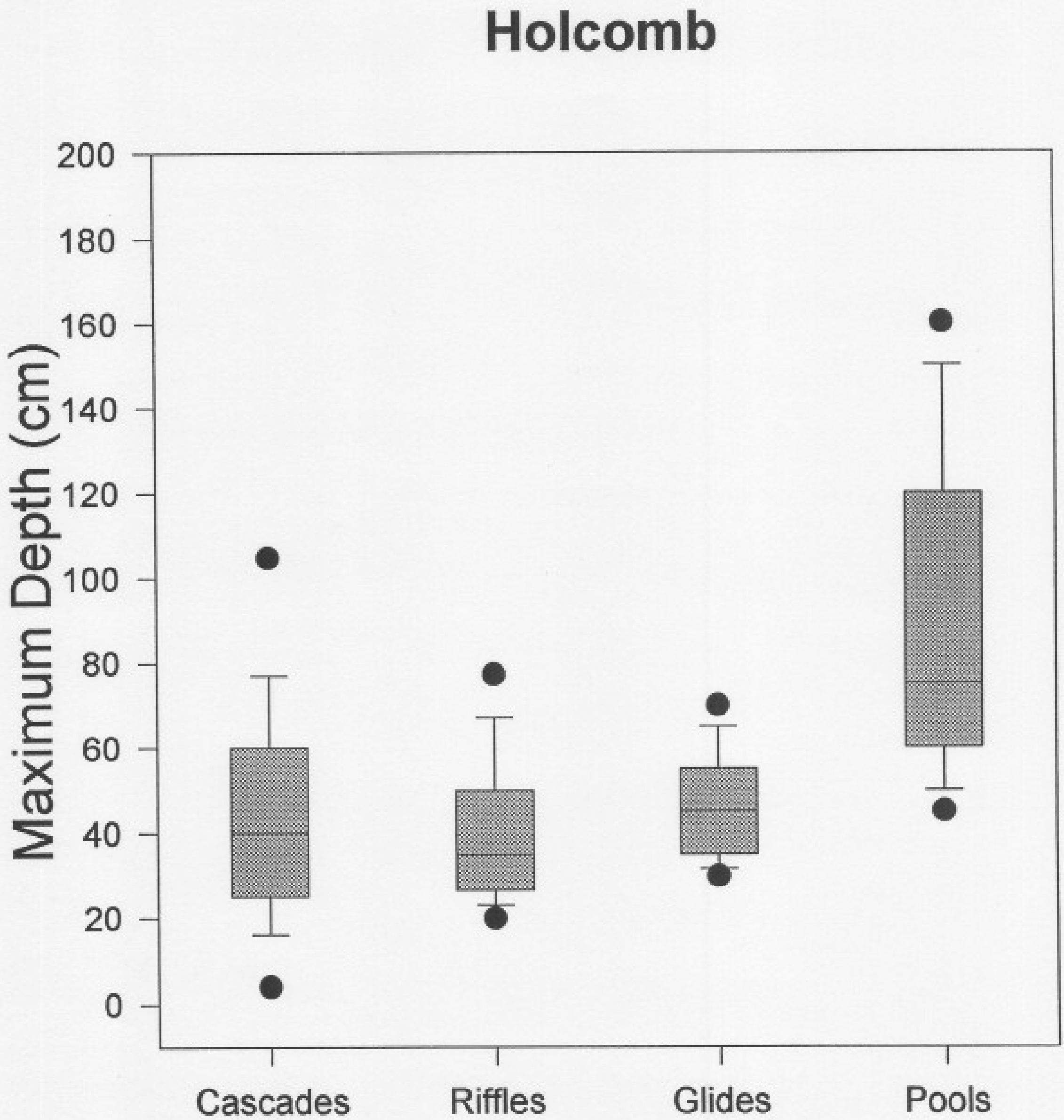
Holcomb

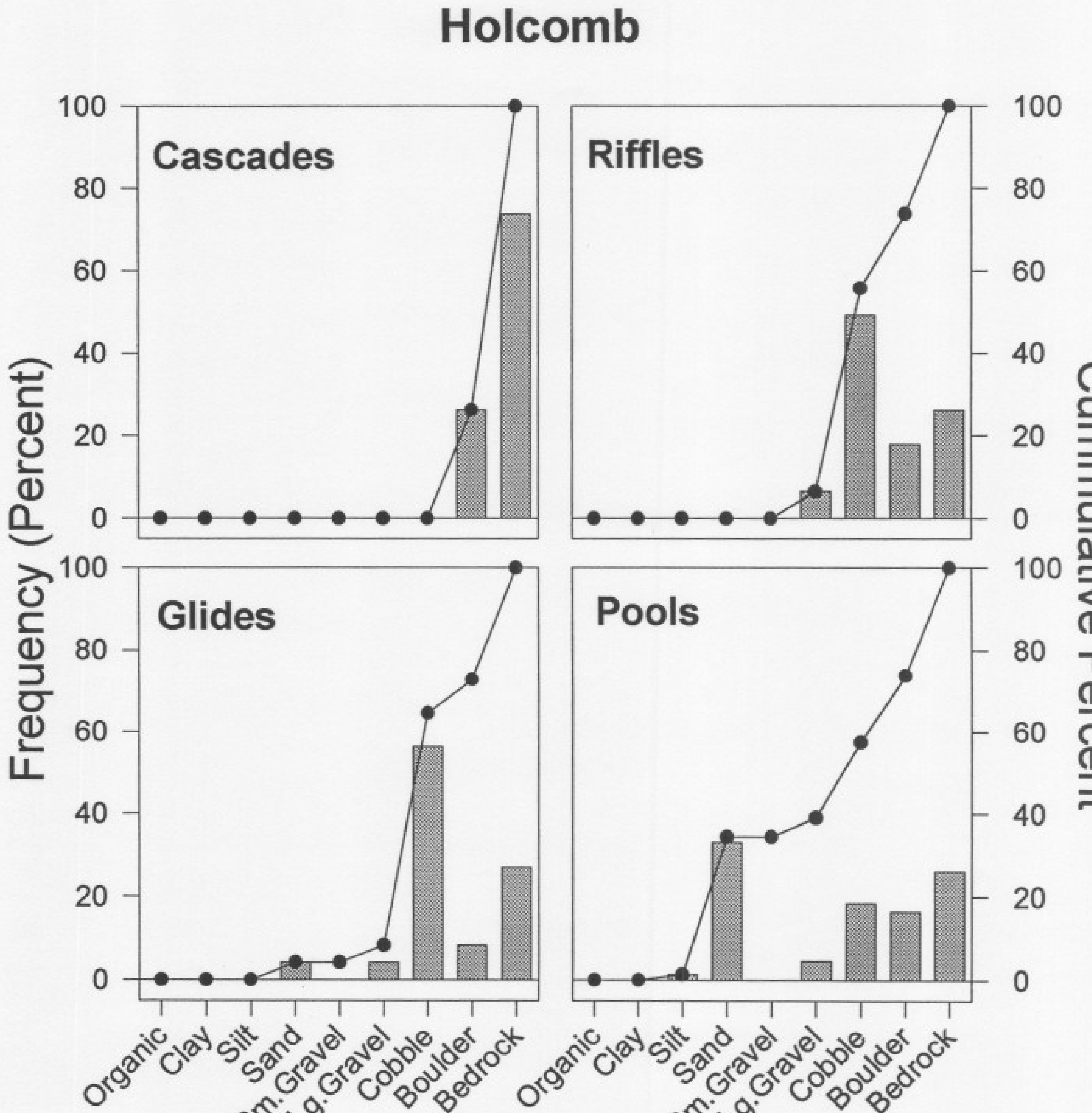


Adult
Rainbow Trout
Brown Trout
Trout species
YOY
Three Forks
Splashdam
Billingsley Creek
Addie Branch
Ammons Creek
Density (Number/100m²)
100
80
60
40
20
0
20
40
0
1000
2000
3000
4000
5000
6000
7000
8000
Distance (meters)

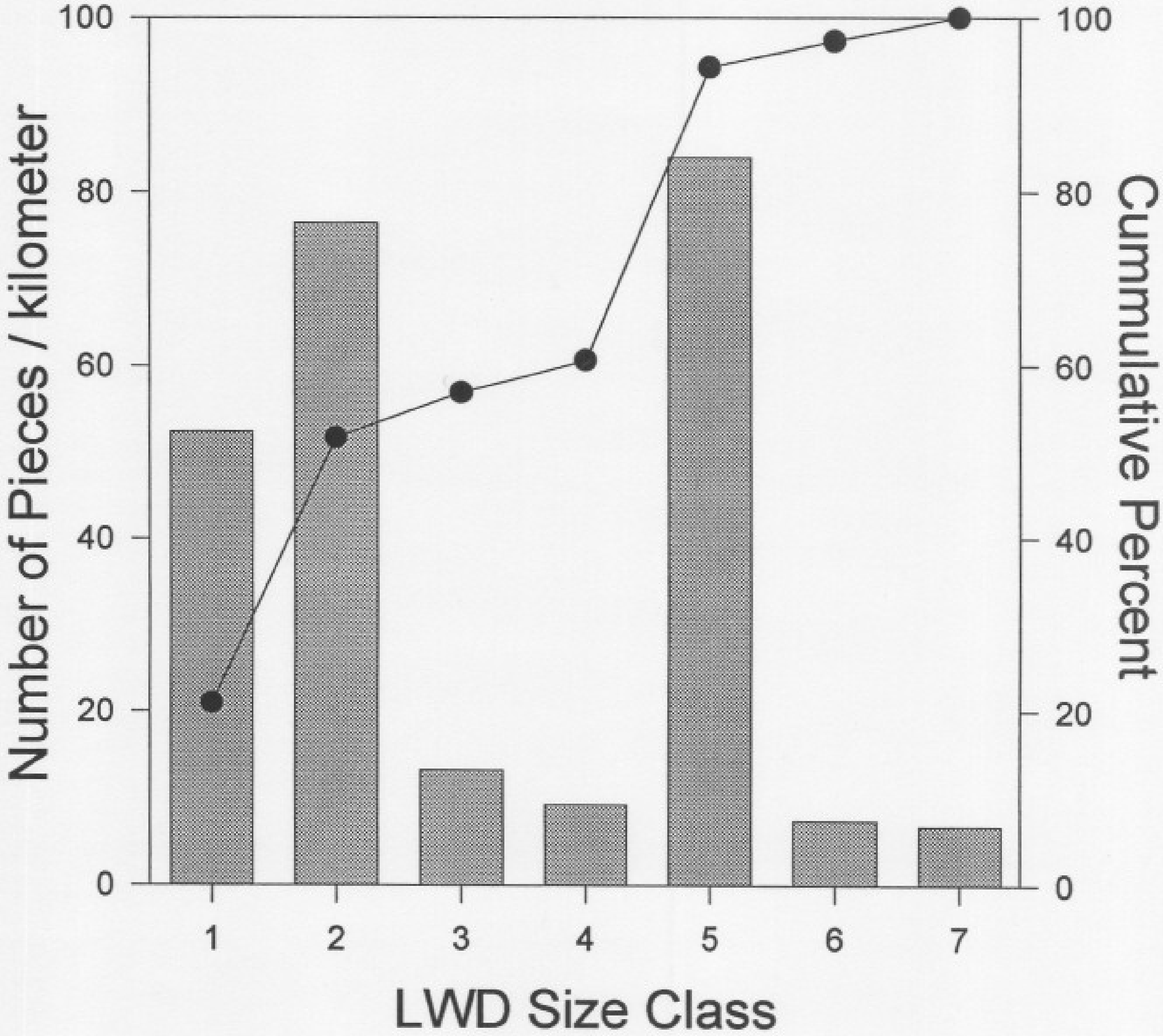
Holcomb


1000
800
600
400
200
0
Corrected Area (m^2)
Cascades
Riffles
Glides
Pools


Holcomb
Maximum Depth (cm)
200
180
160
140
120
100
80
60
40
20
0
Cascades
Riffles
Glides
Pools

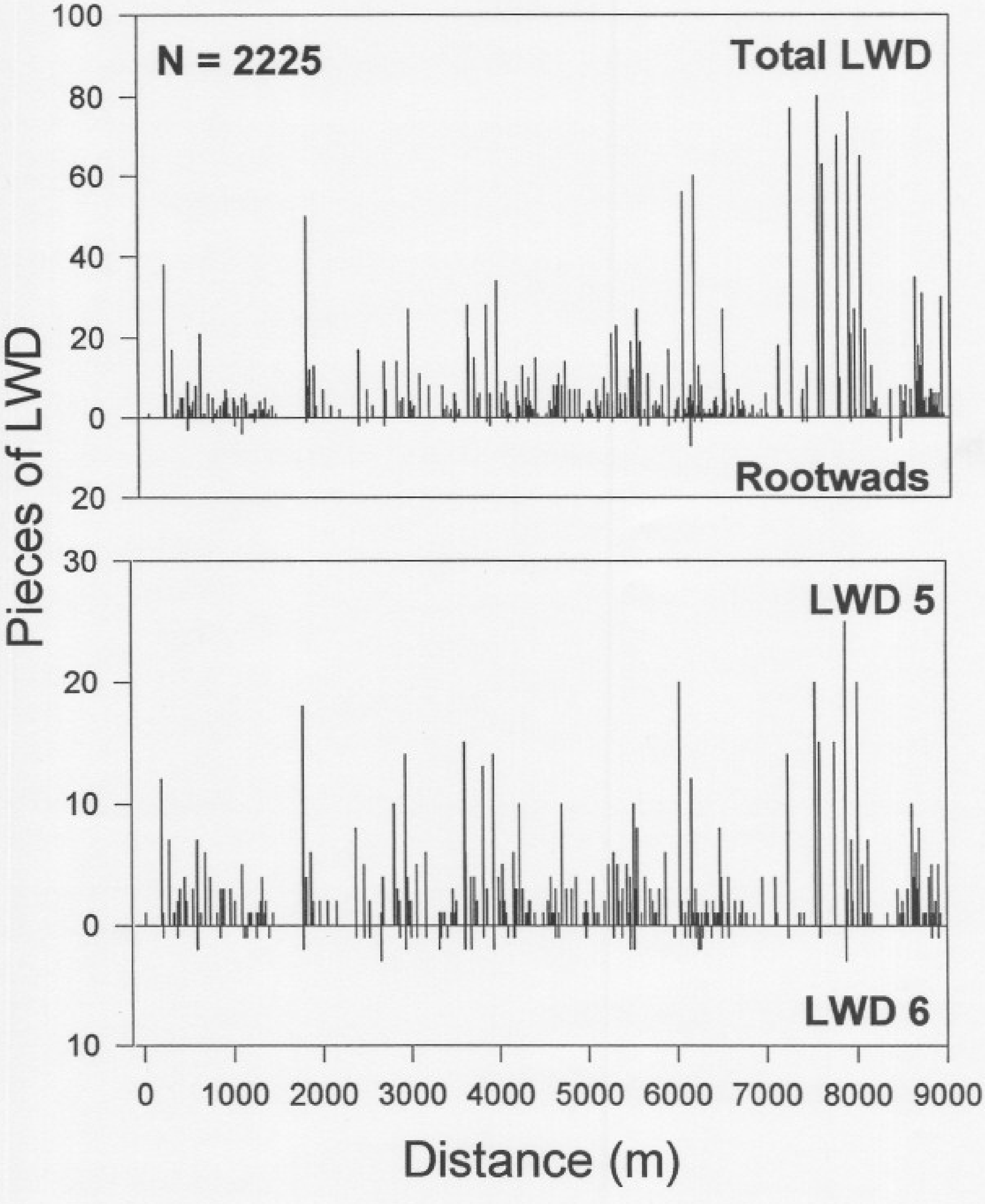

Holcomb
Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

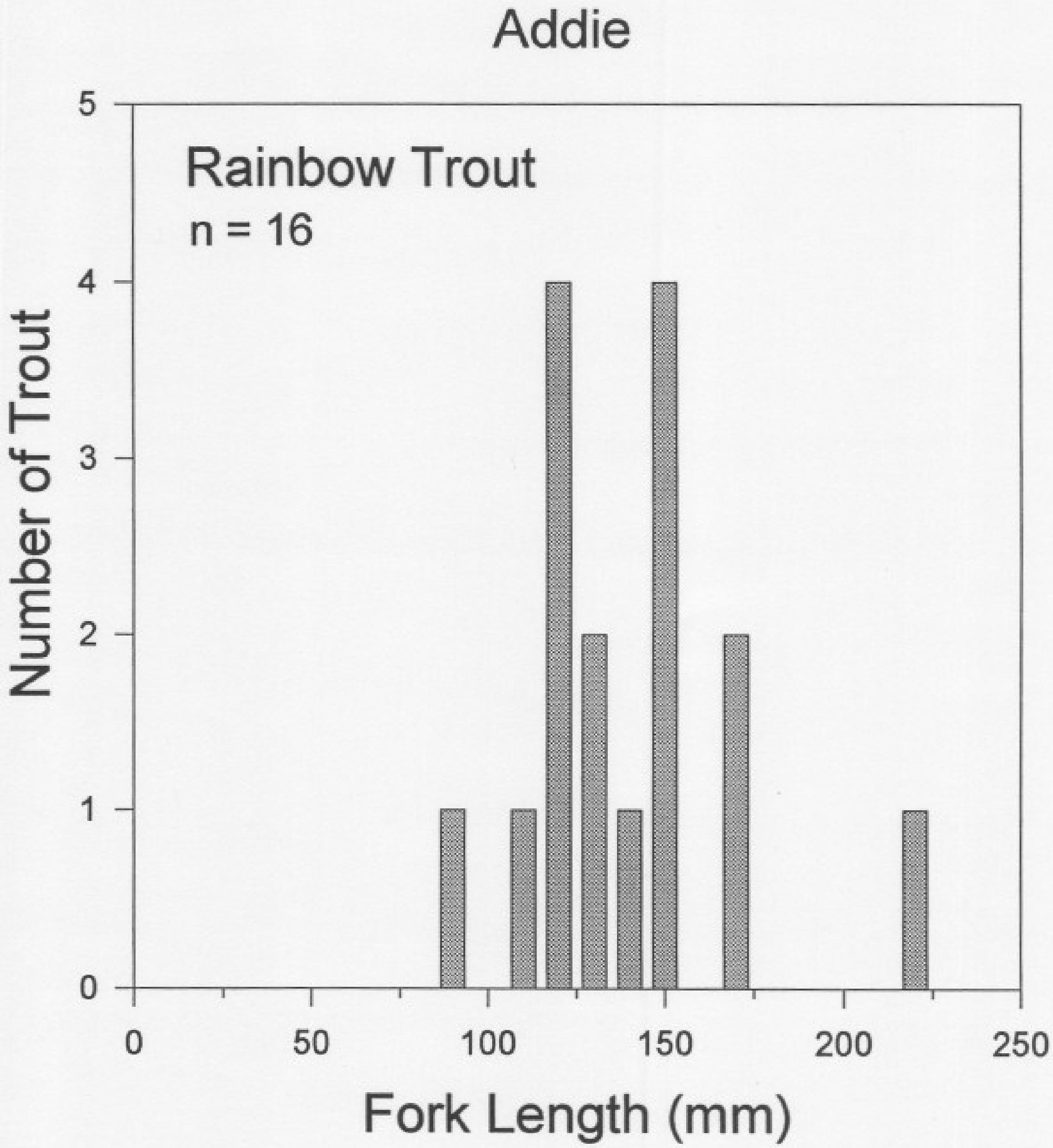
Holcomb



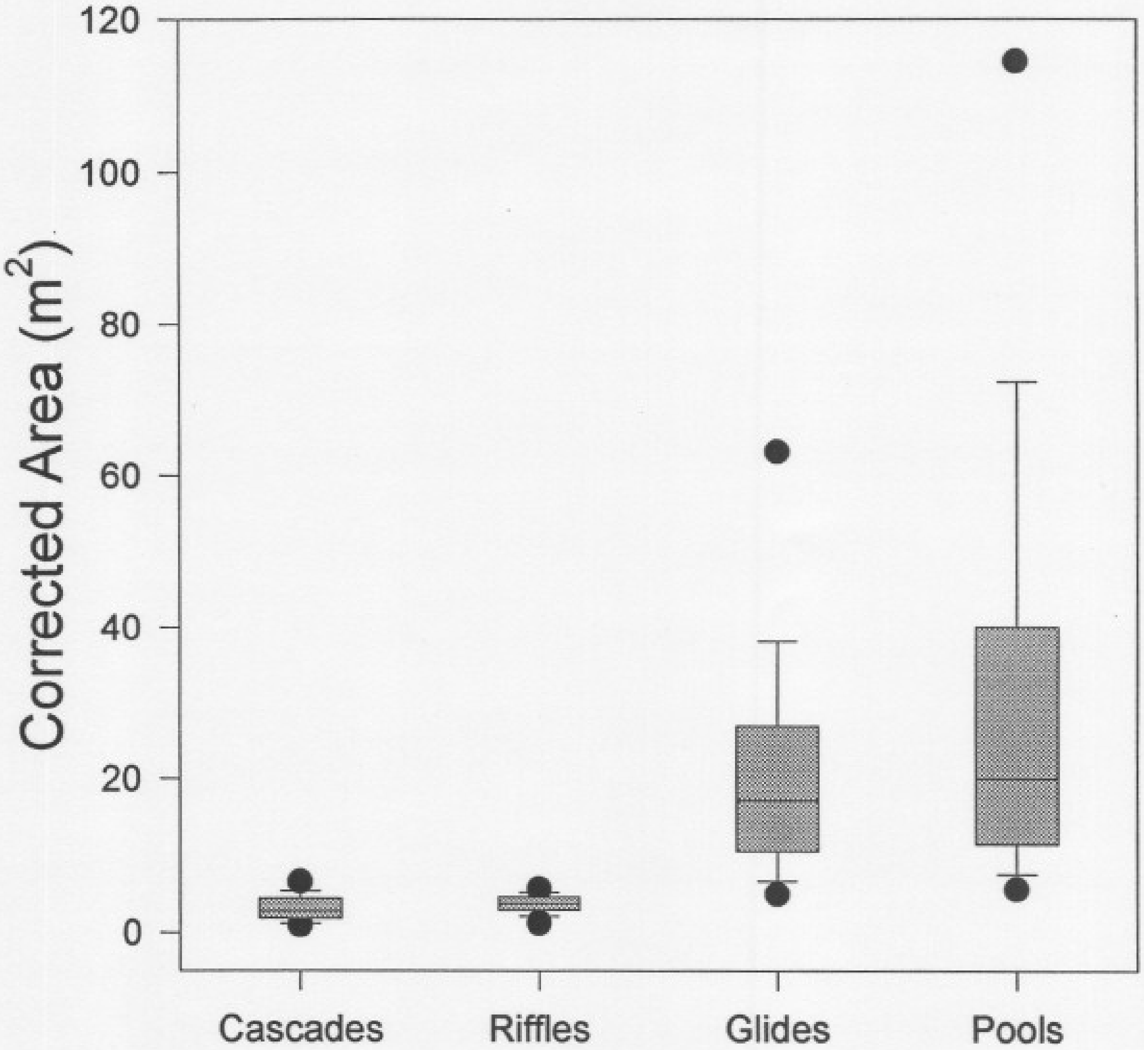
100
80
60
40
20
0
Number of Pieces / kilometer
100
80
60
40
20
0
Cummulative Percent
1
2
3
4
5
6
7
LWD Size Class

Holcomb


N = 2225
Total LWD
Rootwads
LWD 5
LWD 6
Pieces of LWD
Distance (m)
100
80
60
40
20
0
20
30
20
10
0
10
0 1000 2000 3000 4000 5000 6000 7000 8000 9000

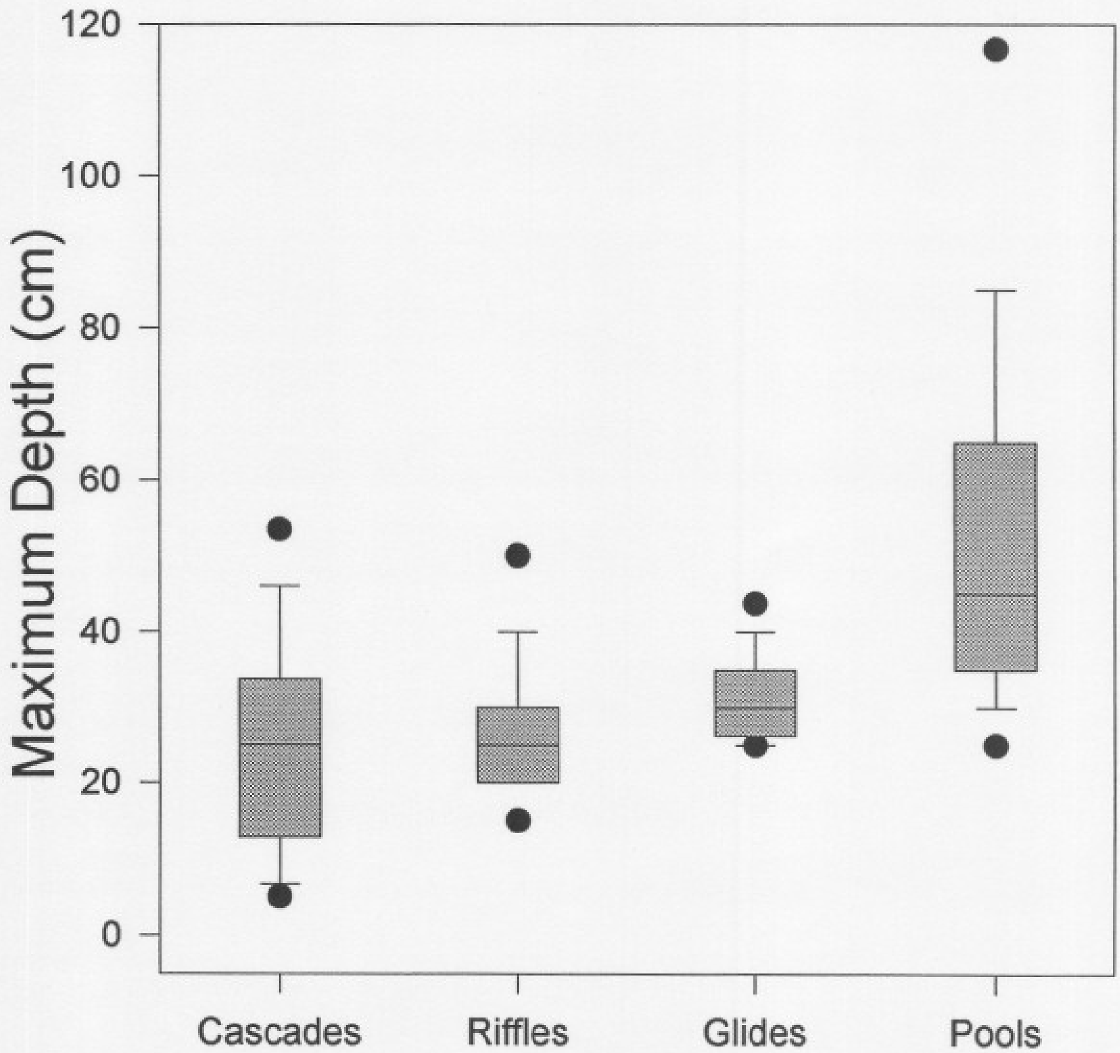

Addie
Rainbow Trout
n = 16
Number of Trout
Fork Length (mm)
0
1
2
3
4
5
0
50
100
150
200
250

Addie



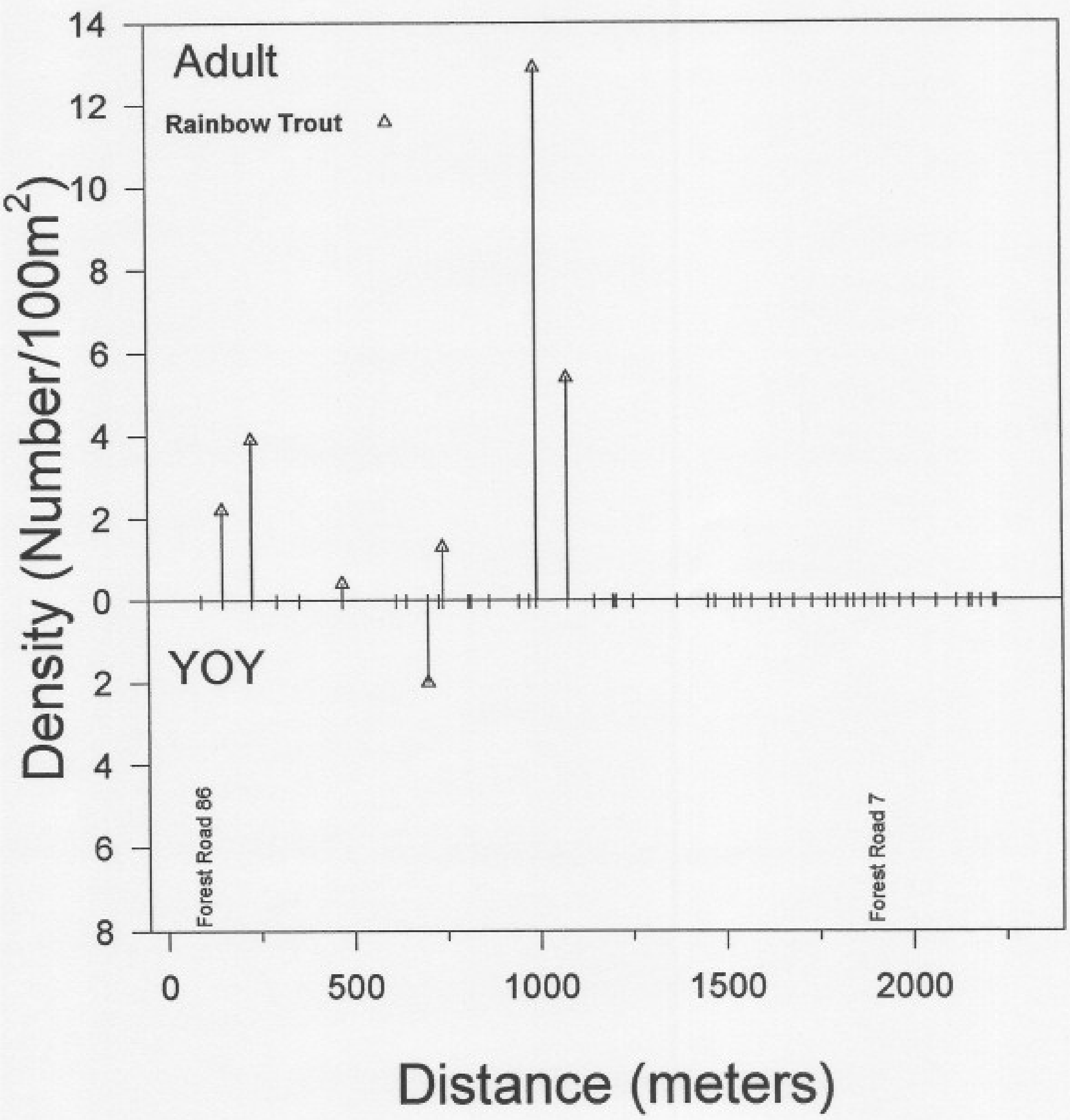
120
100
80
60
40
20
0
Corrected Area (m^2)
Cascades
Riffles
Glides
Pools

Addie

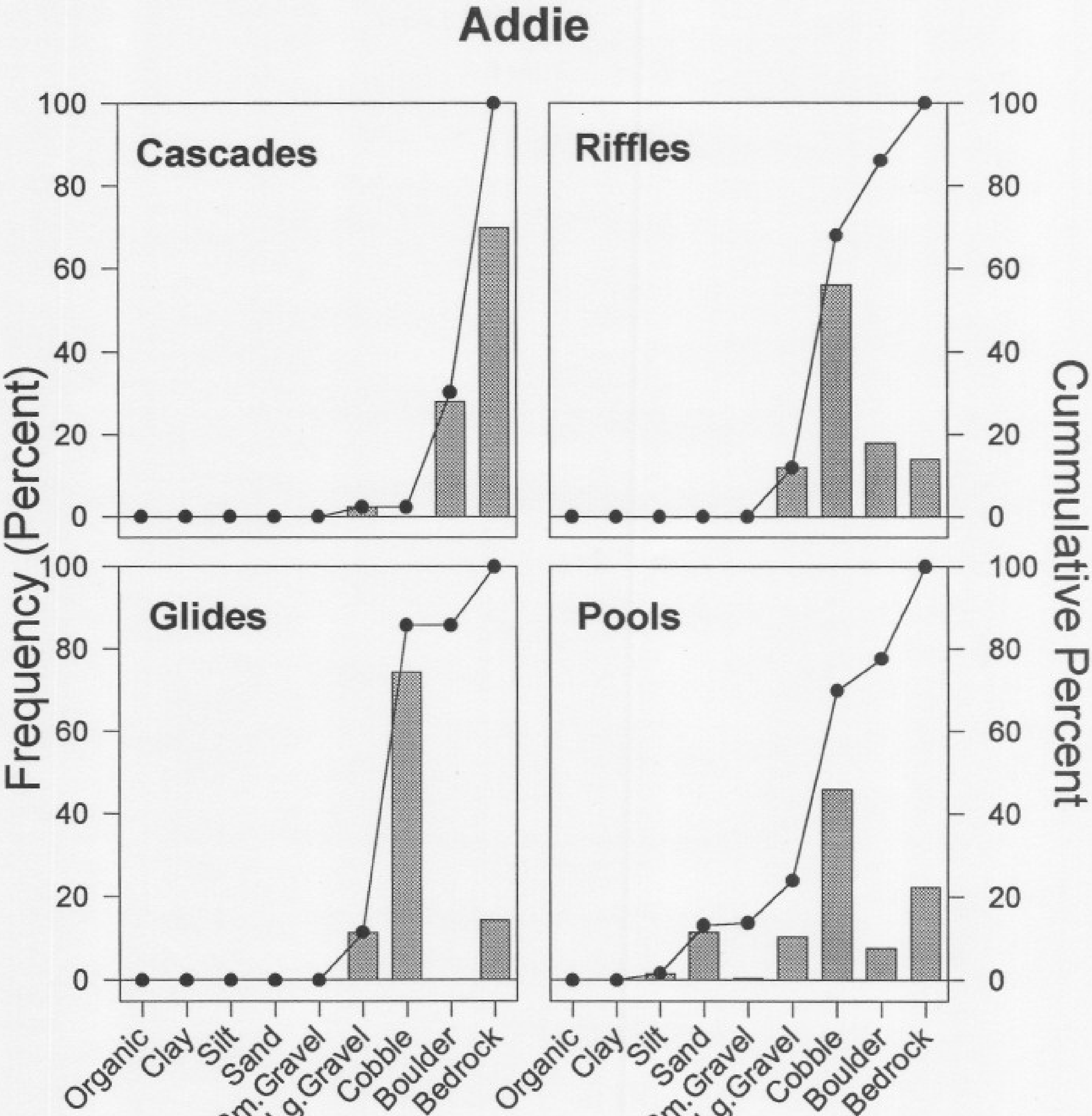


Maximum Depth (cm)
0
20
40
60
80
100
120
Cascades
Riffles
Glides
Pools

Addie

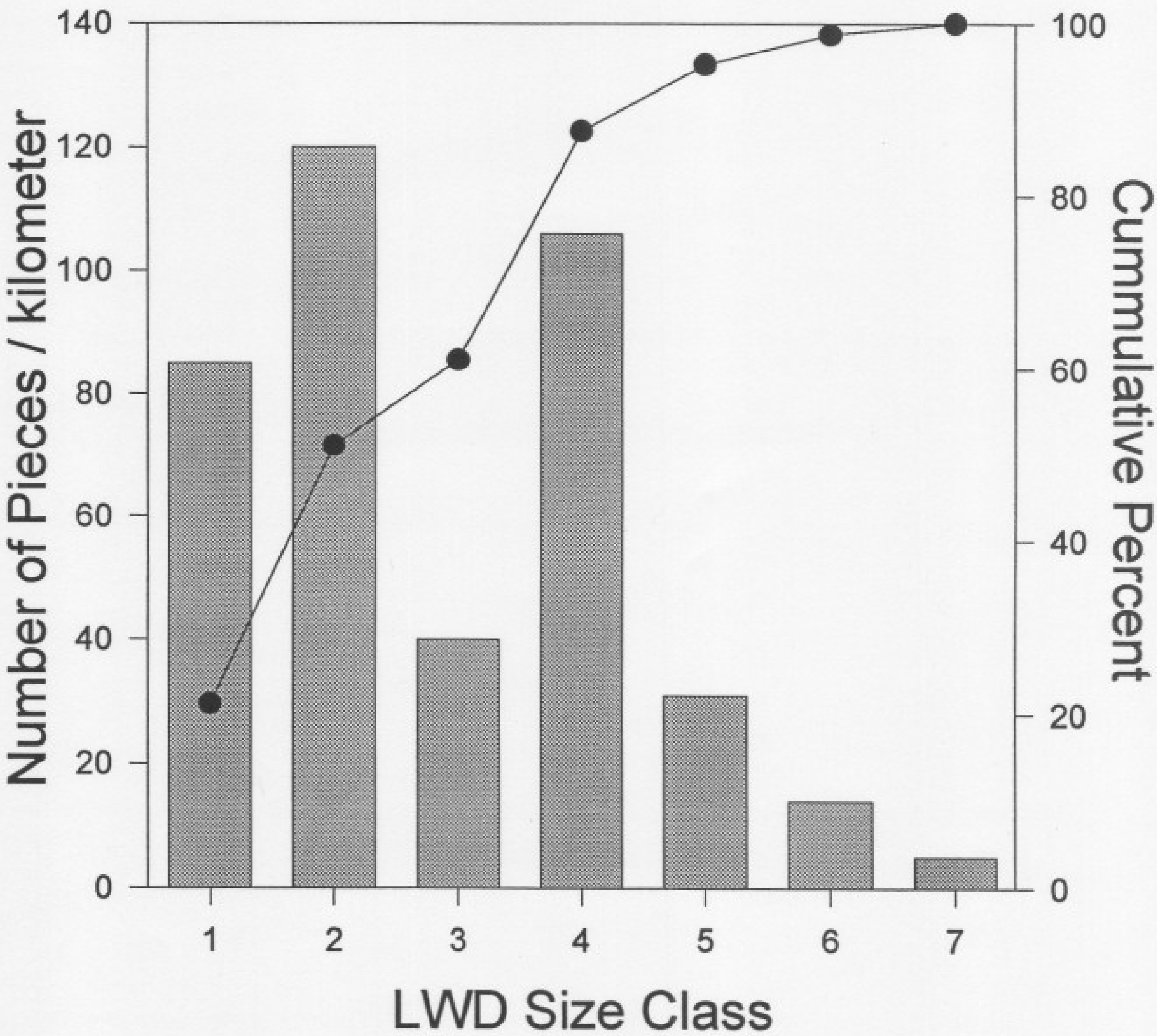


Adult
Rainbow Trout
YOY
Density (Number/100m^2)
14
12
10
8
6
4
2
0
2
4
6
8
Forest Road 86
Forest Road 7
0
500
1000
1500
2000
Distance (meters)



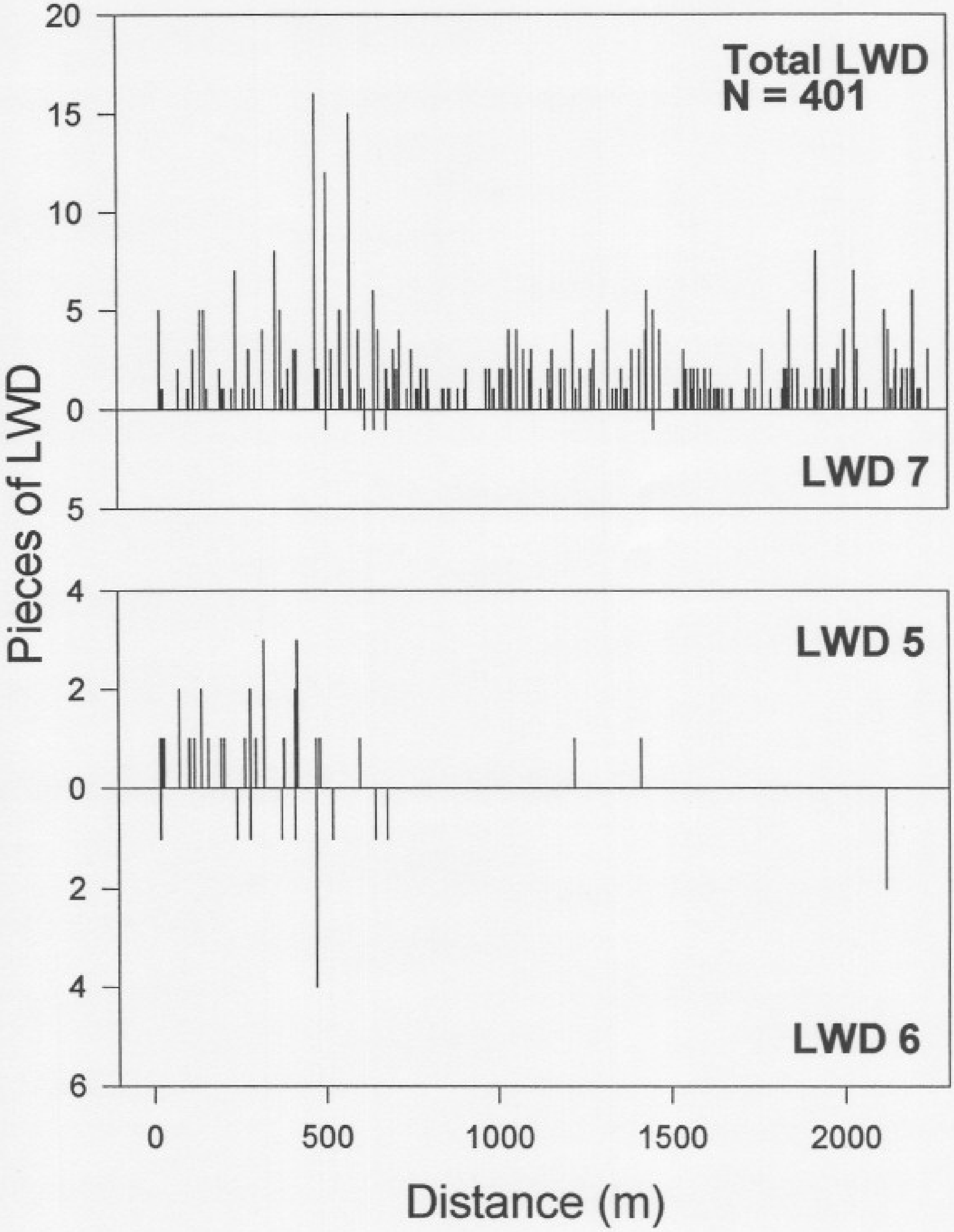
Addie
Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

Addie

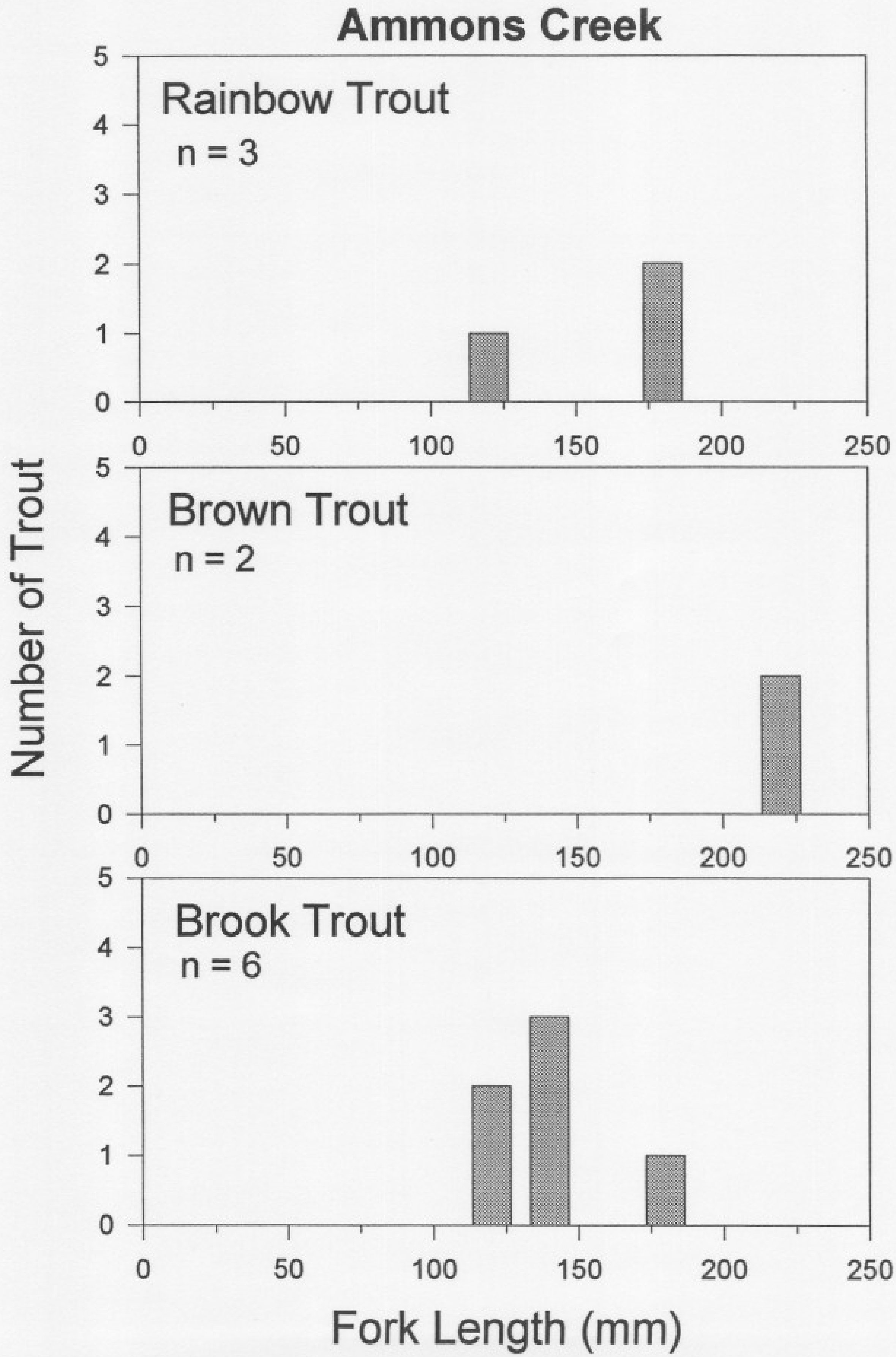


Number of Pieces / kilometer
Cummulative Percent
LWD Size Class
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7

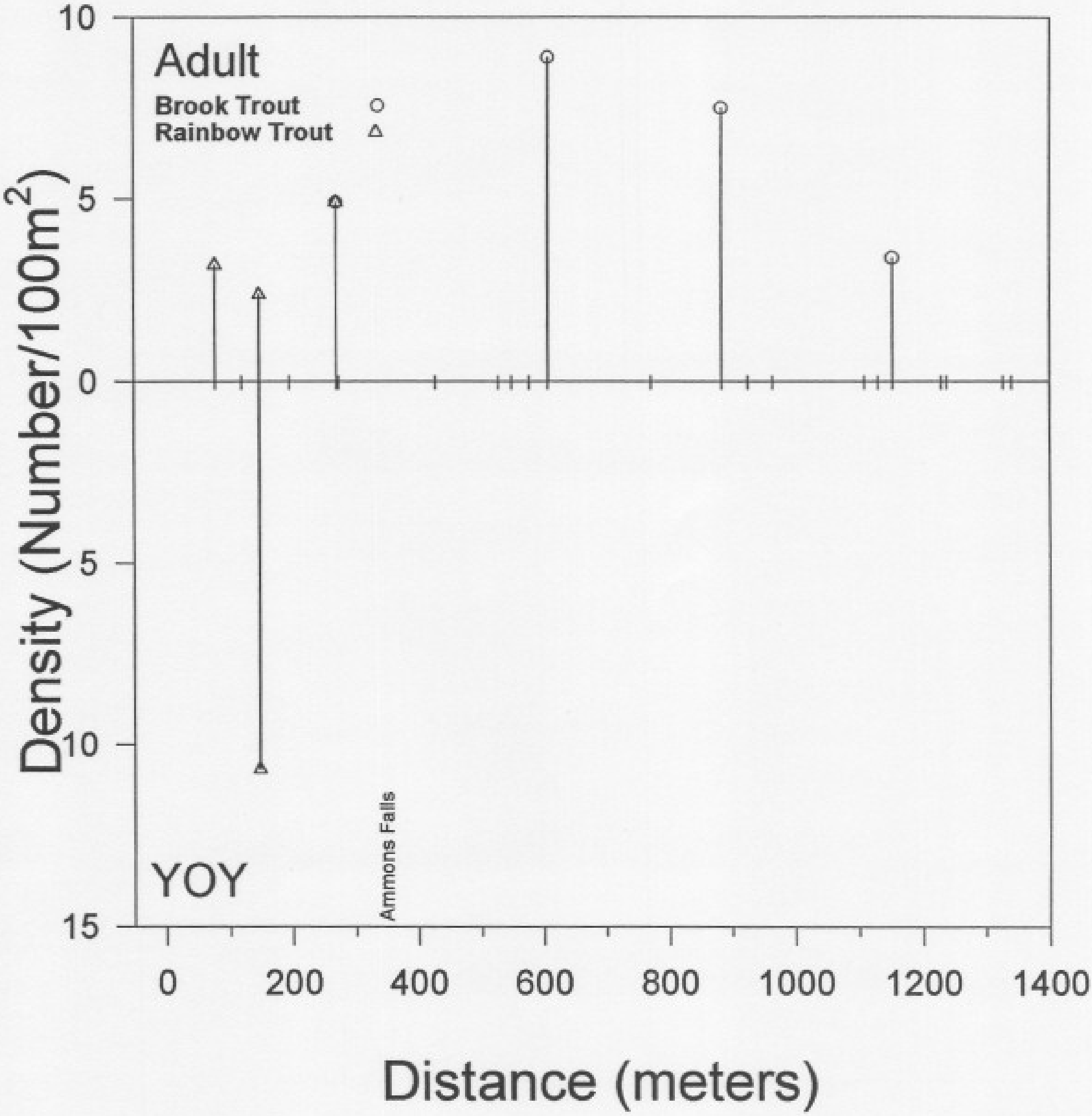
Addie



Total LWD
N = 401
LWD 7
LWD 5
LWD 6
Pieces of LWD
Distance (m)
20
15
10
5
0
5
4
2
0
2
4
6
0
500
1000
1500
2000

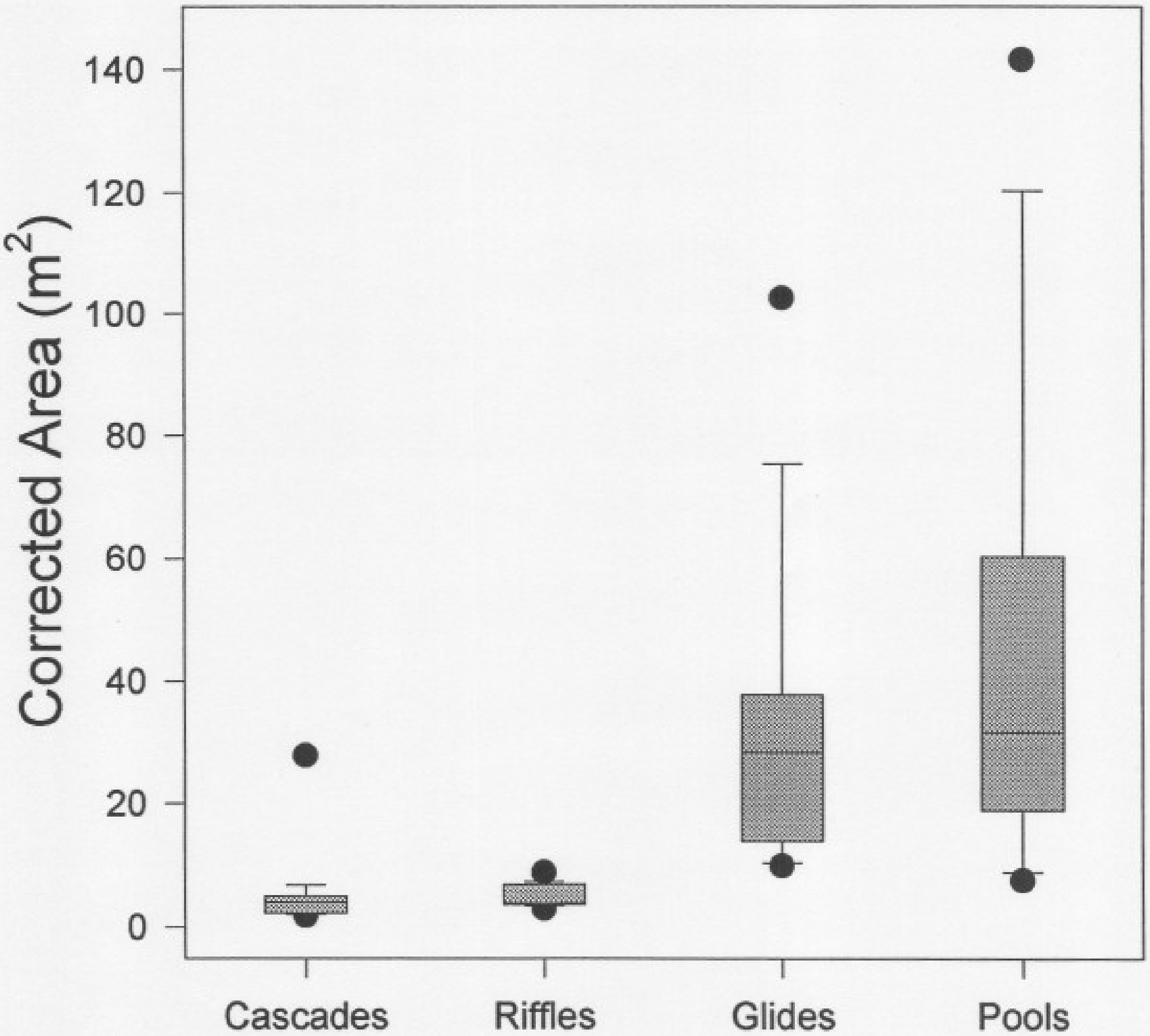

Ammons Creek
Rainbow Trout
n = 3
Brown Trout
n = 2
Brook Trout
n = 6
Number of Trout
Fork Length (mm)
0
1
2
3
4
5
0
50
100
150
200
250

Ammons

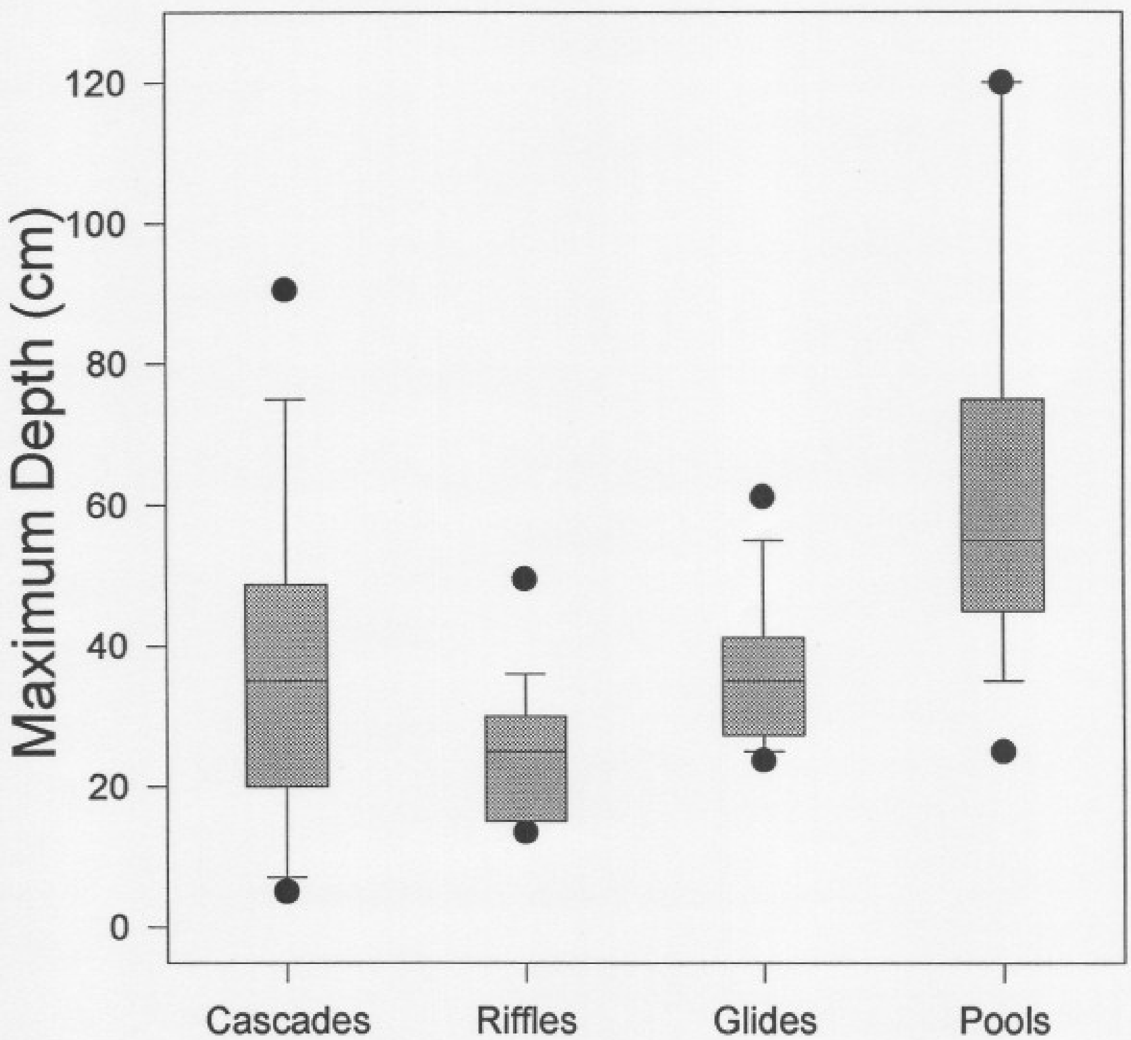


Adult
Brook Trout
Rainbow Trout
YOY
Ammons Falls
Density (Number/100m2)
10
5
0
5
10
15
0
200
400
600
800
1000
1200
1400
Distance (meters)

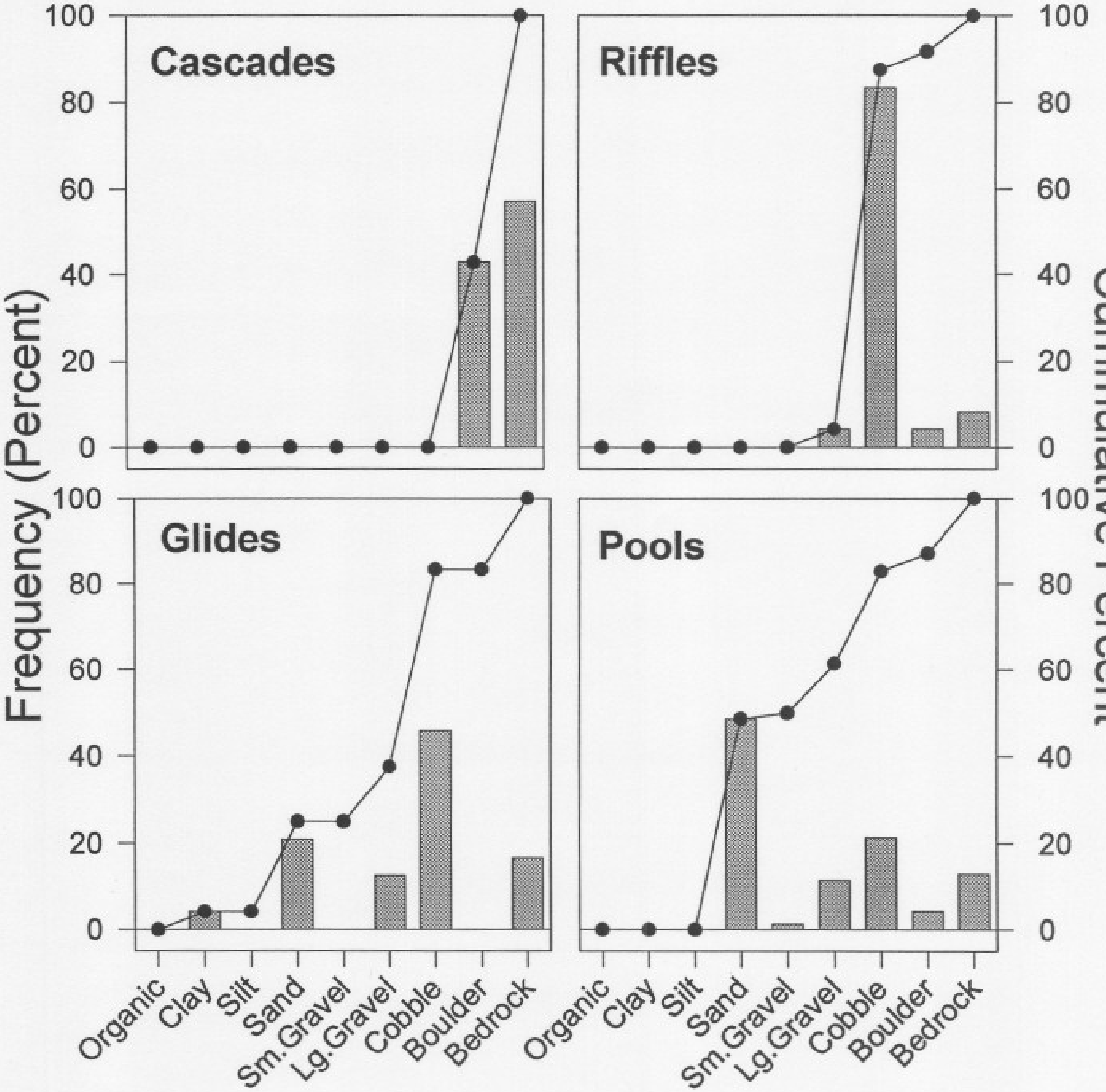
Ammons


Corrected Area (m^2)
0
20
40
60
80
100
120
140
Cascades
Riffles
Glides
Pools

Ammons

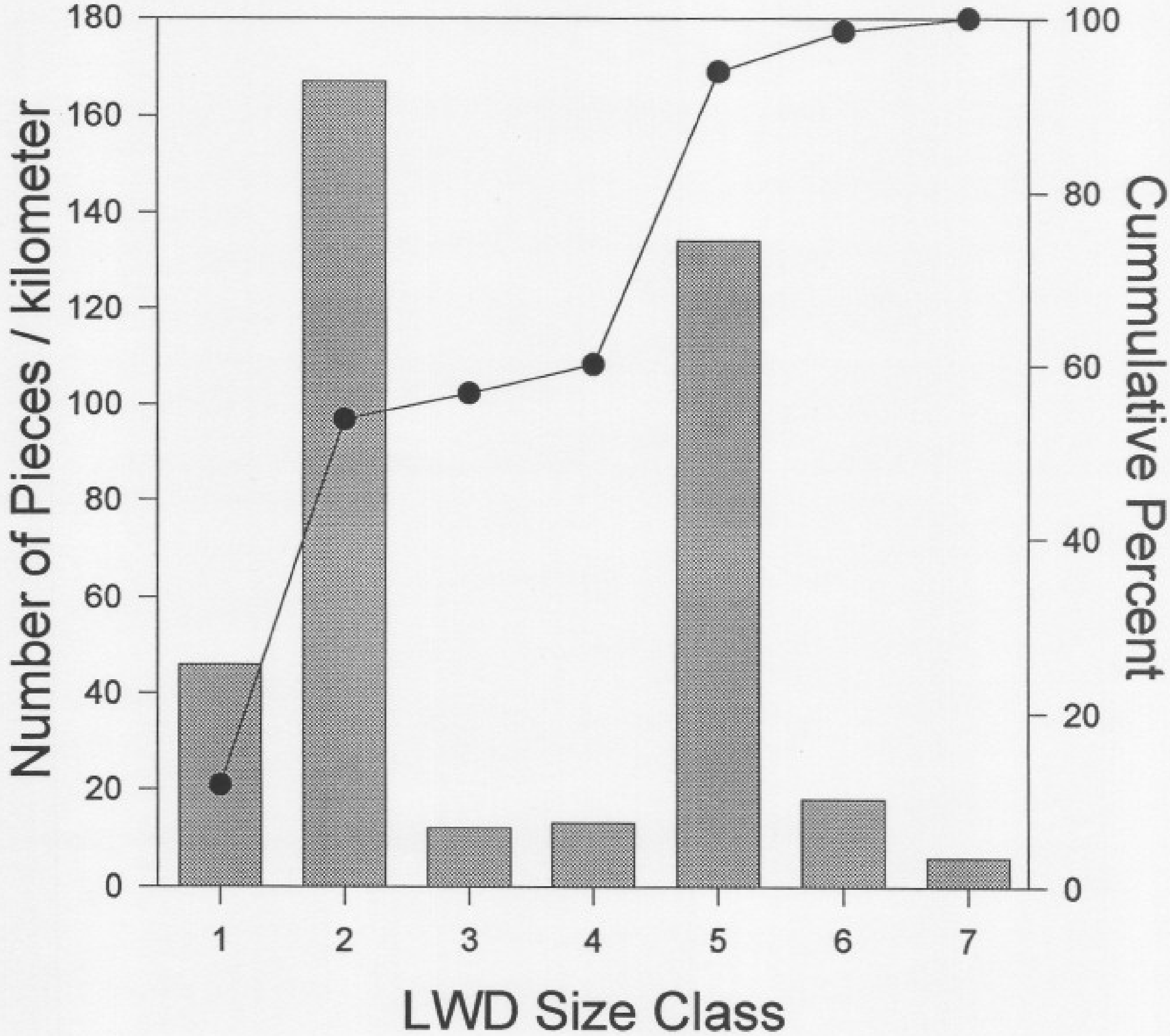

Maximum Depth (cm)
0
20
40
60
80
100
120
Cascades
Riffles
Glides
Pools

Ammons



Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

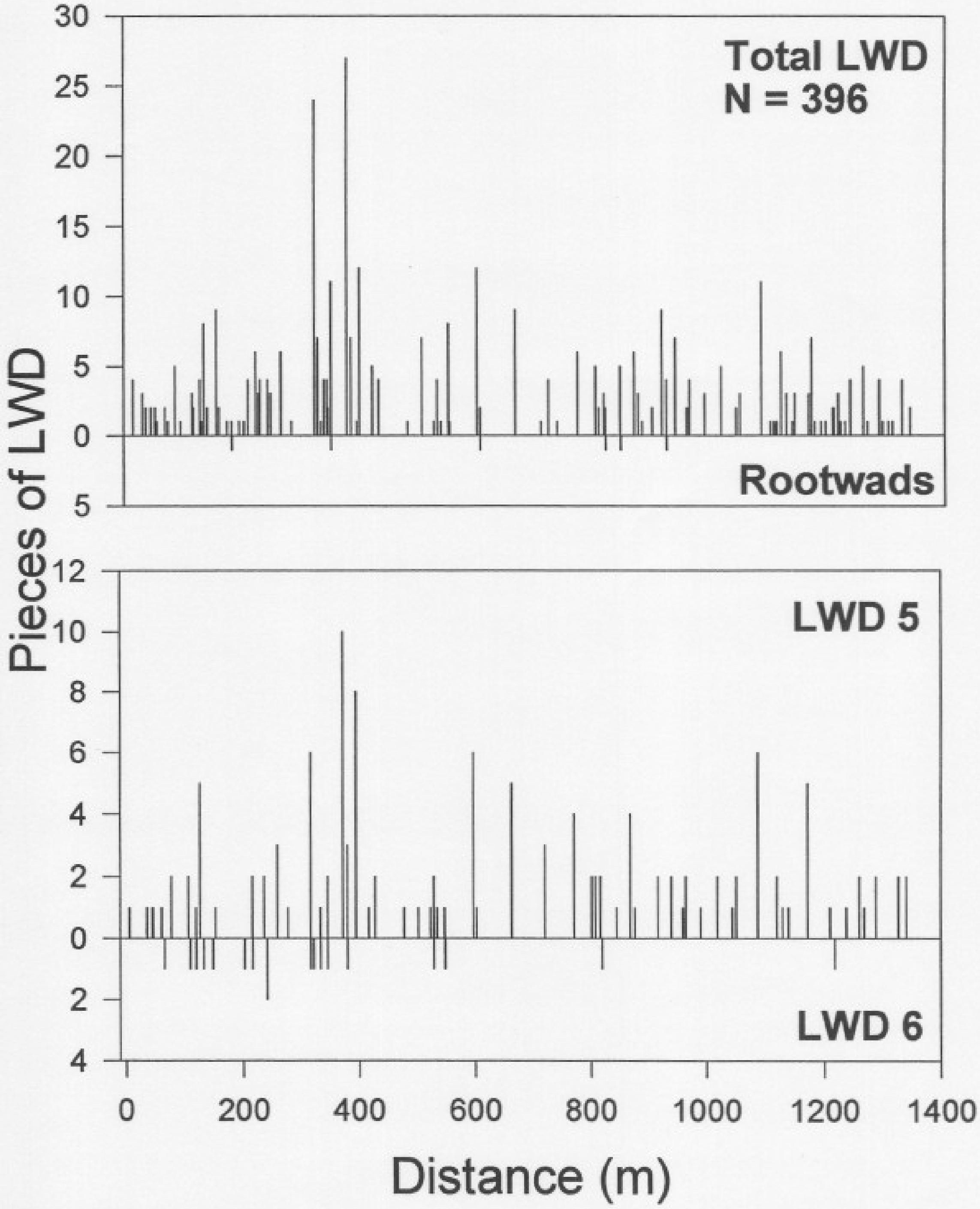
Ammons



Number of Pieces / kilometer
0
20
40
60
80
100
120
140
160
180
Cummulative Percent
0
20
40
60
80
100
1
2
3
4
5
6
7
LWD Size Class

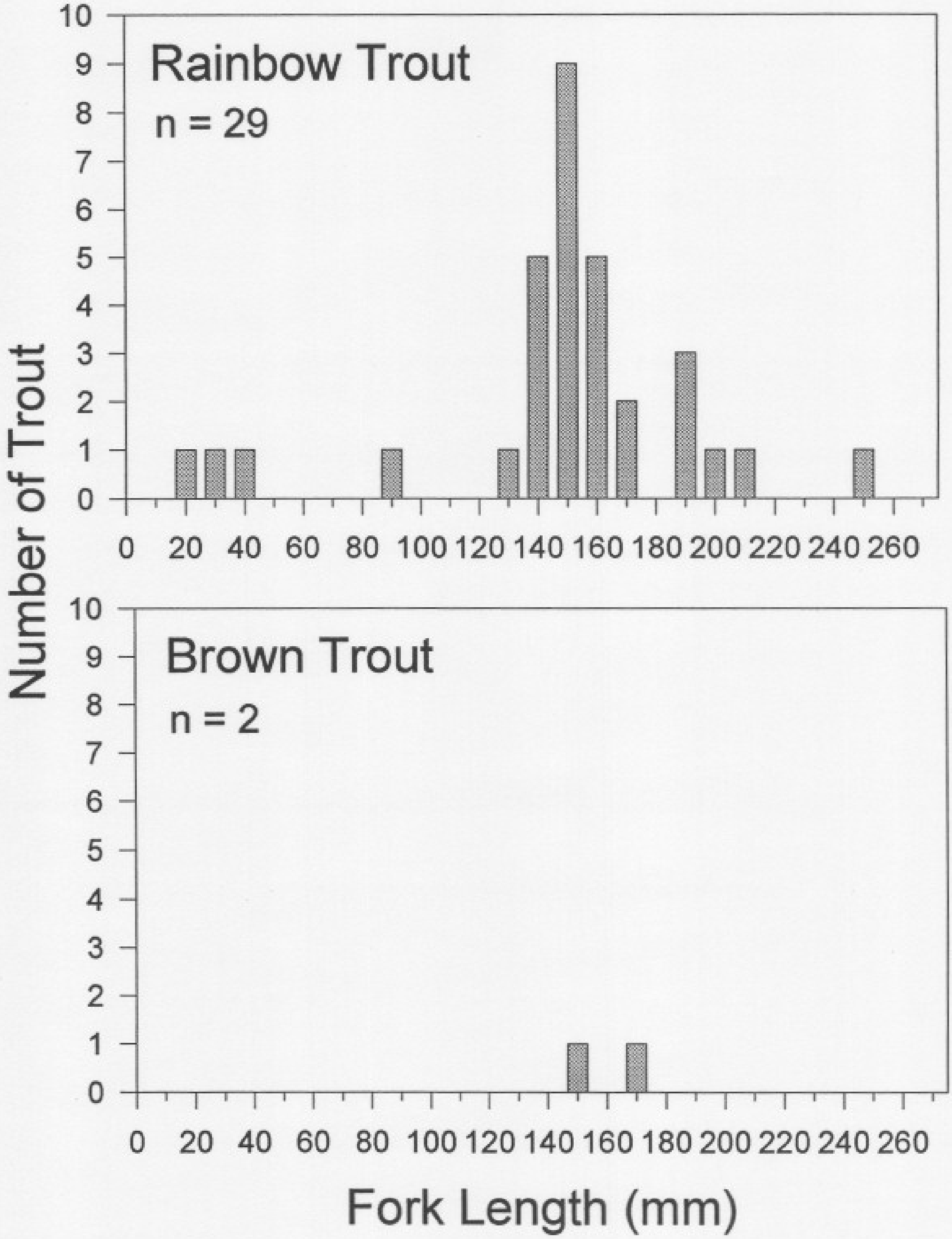
Overflow Creek Basin

Ammons

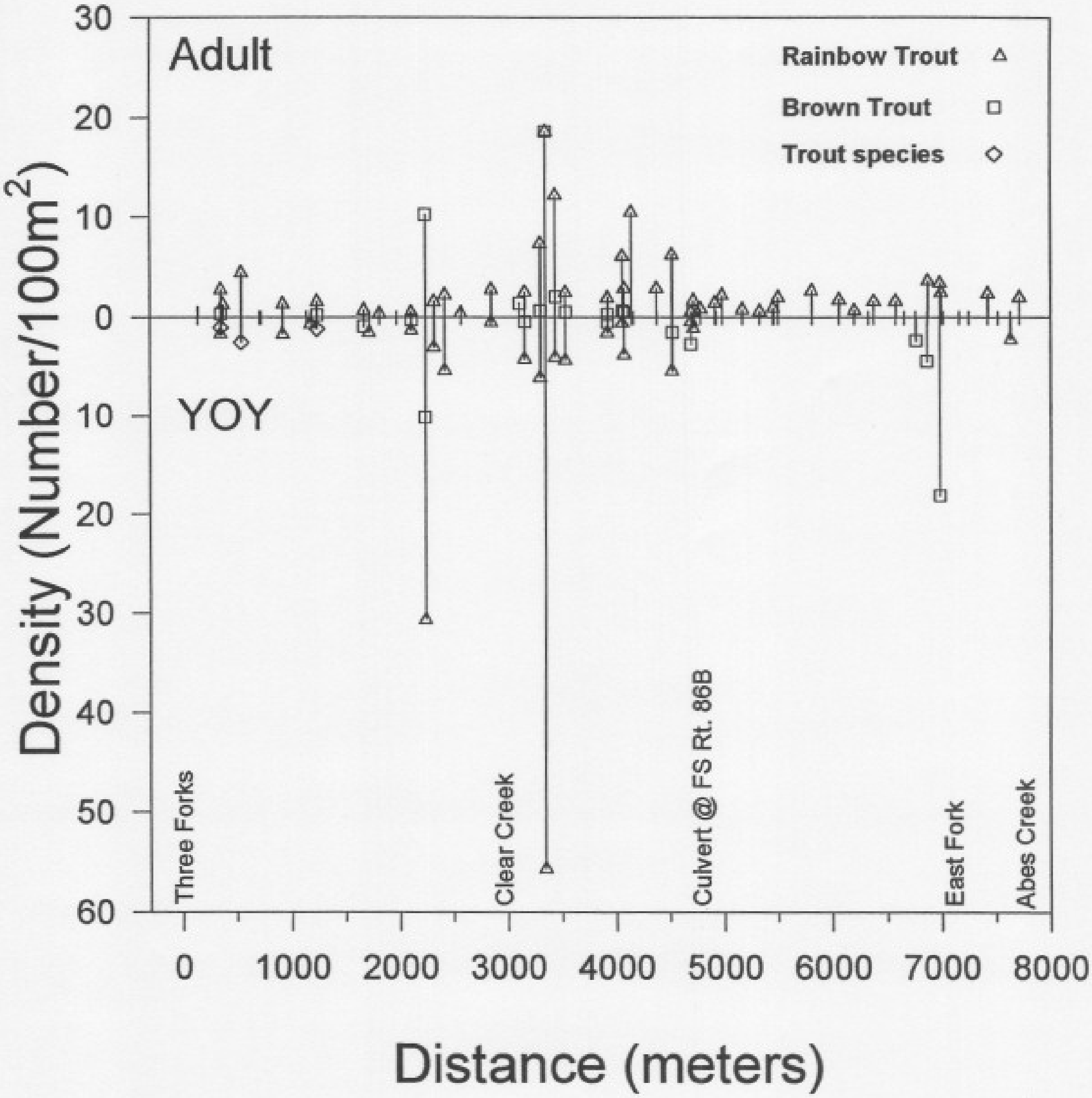


Total LWD
N = 396
Rootwads
LWD 5
LWD 6
Pieces of LWD
Distance (m)
30
25
20
15
10
5
0
5
12
10
8
6
4
2
0
2
4
0
200
400
600
800
1000
1200
1400

Overflow

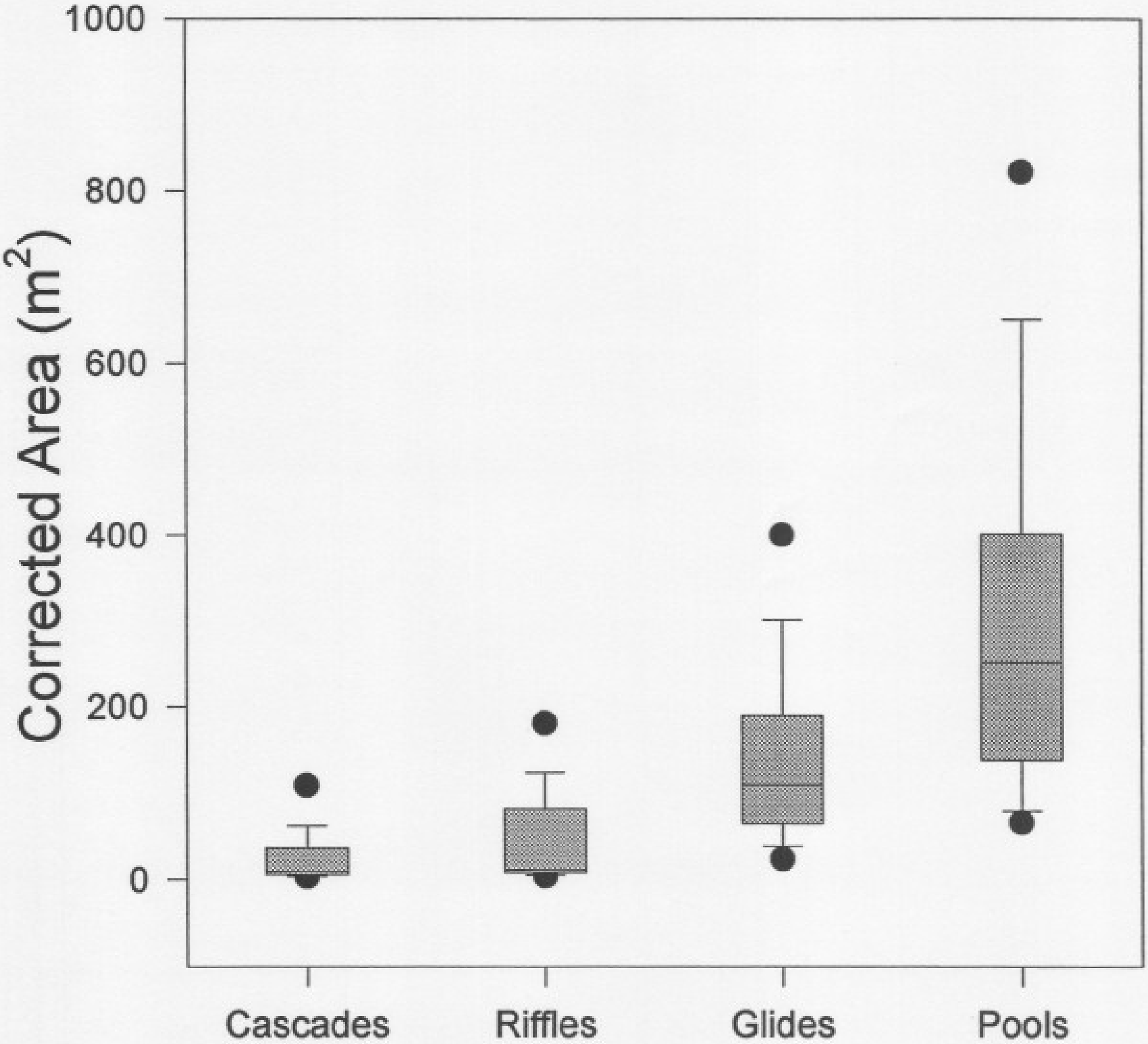

Rainbow Trout
n = 29
Brown Trout
n = 2
Number of Trout
Fork Length (mm)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
0
1
2
3
4
5
6
7
8
9
10

Overflow

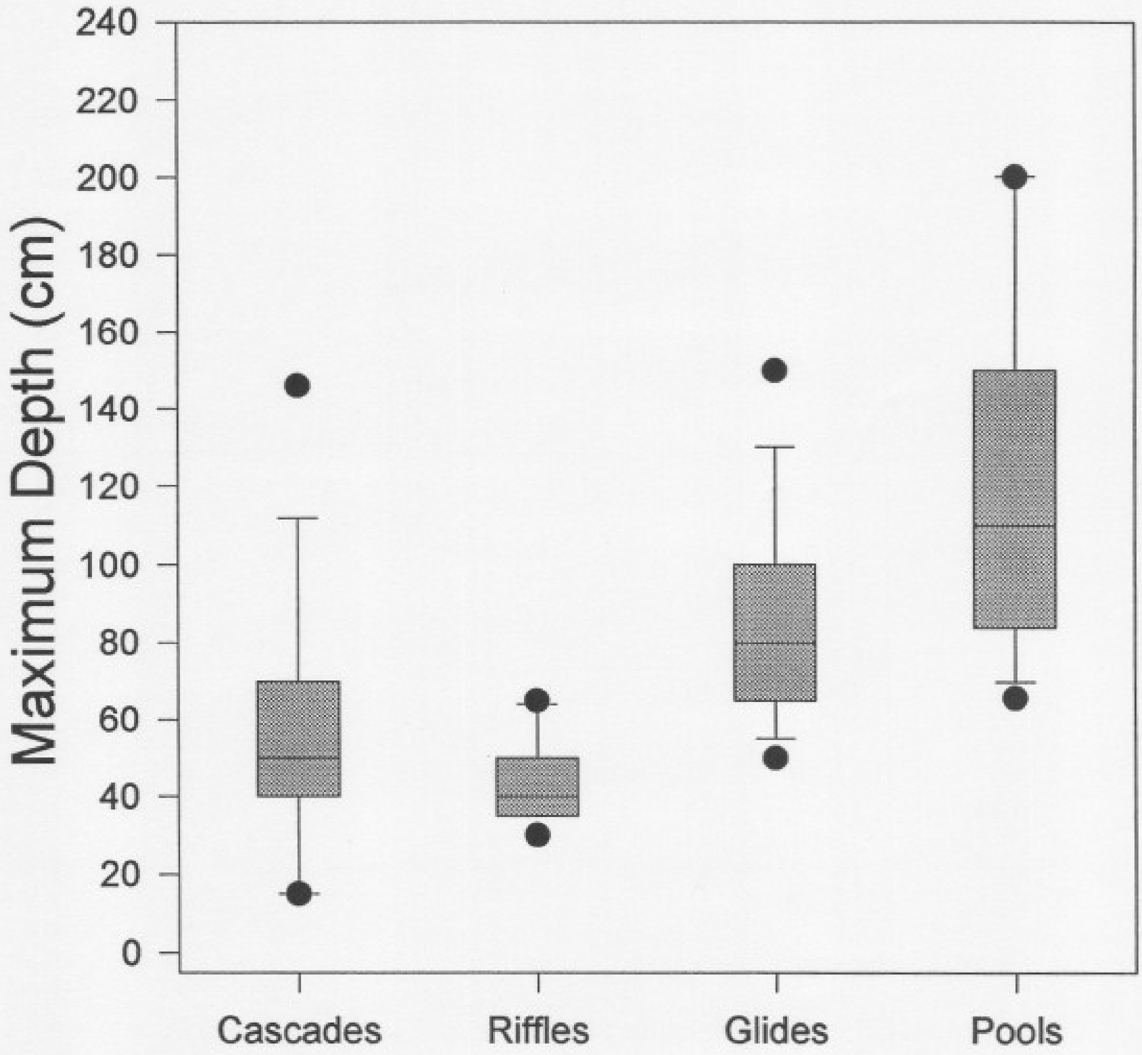


Adult
YOY
Rainbow Trout
Brown Trout
Trout species
Density (Number/100m²)
30
20
10
0
10
20
30
40
50
60
Three Forks
Clear Creek
Culvert @ FS Rt. 86B
East Fork
Abes Creek
0
1000
2000
3000
4000
5000
6000
7000
8000
Distance (meters)

Overflow

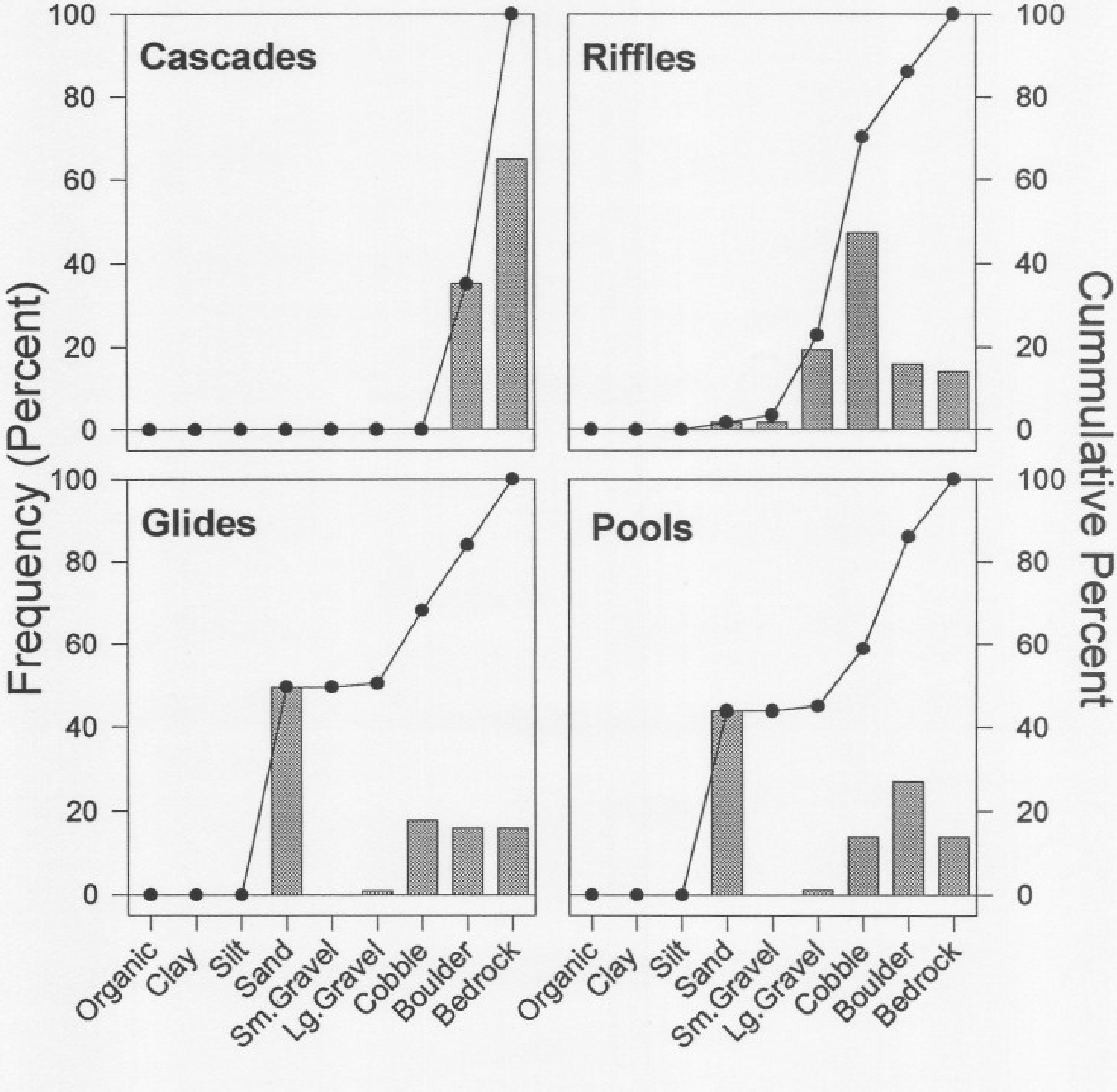

1000
800
600
400
200
0
Corrected Area (m^2)
Cascades
Riffles
Glides
Pools

Overflow

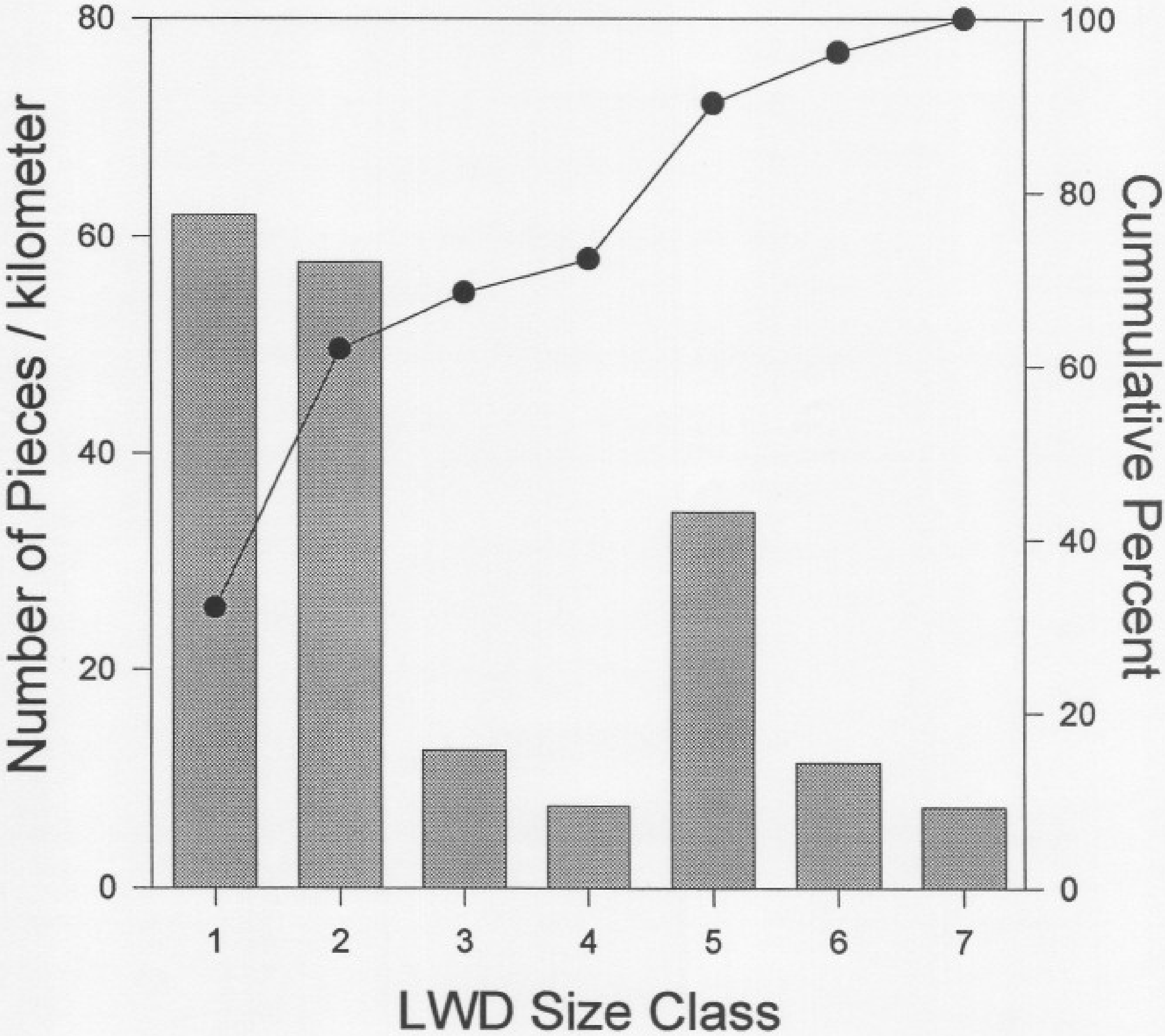


Maximum Depth (cm)
0
20
40
60
80
100
120
140
160
180
200
220
240
Cascades
Riffles
Glides
Pools

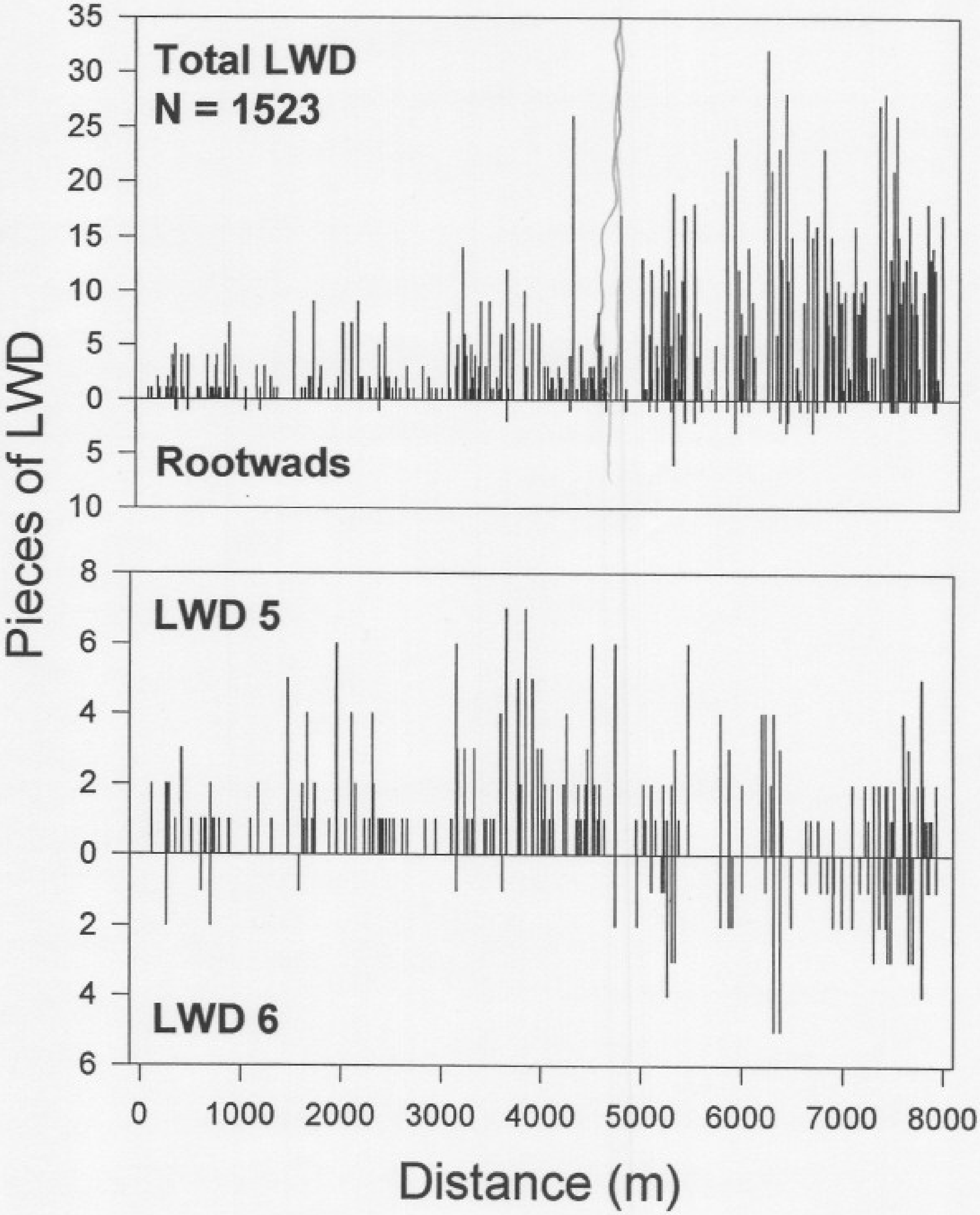
Overflow


Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

Overflow

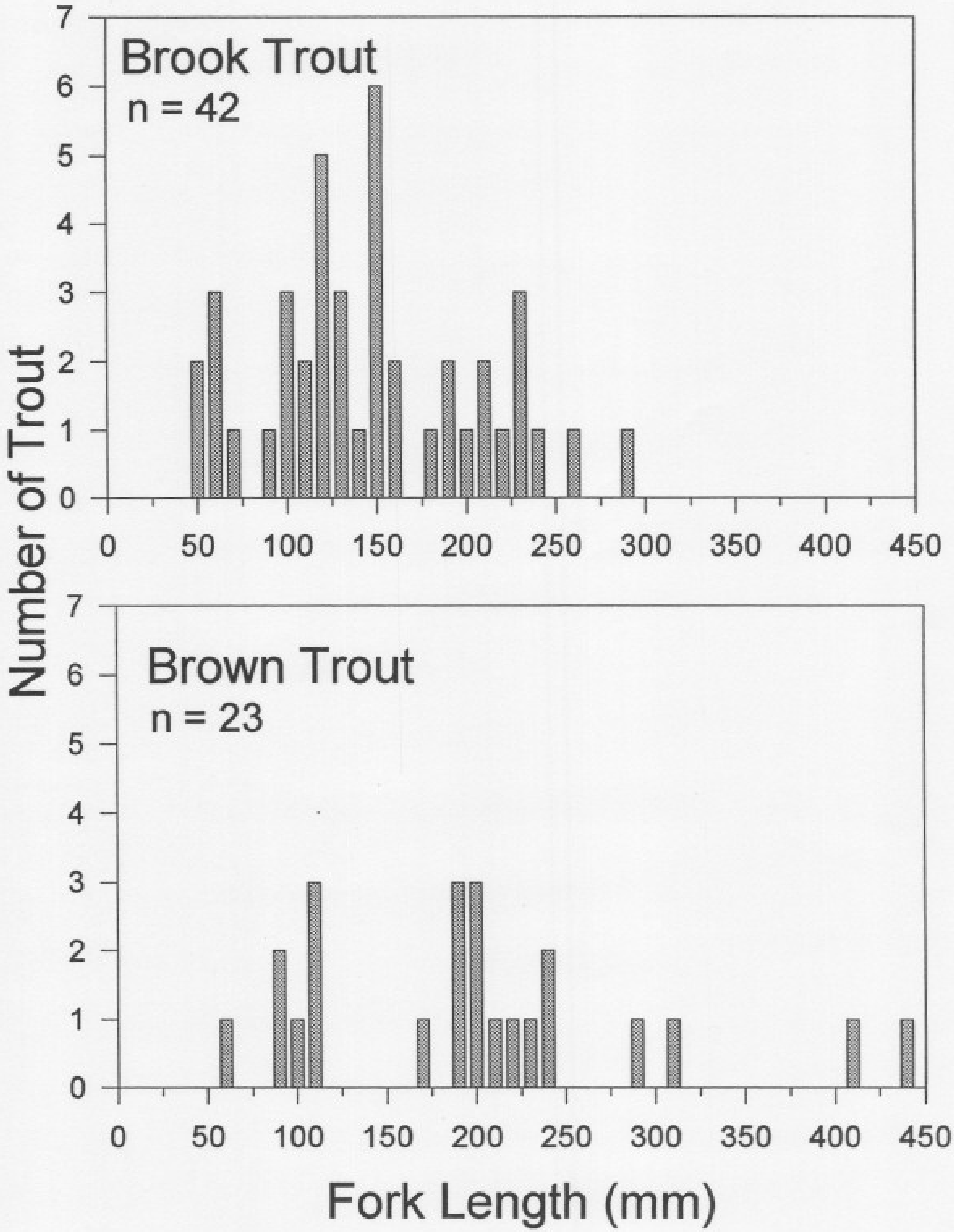

80
60
40
20
0
Number of Pieces / kilometer
100
80
60
40
20
0
Cummulative Percent
1
2
3
4
5
6
7
LWD Size Class

Overflow

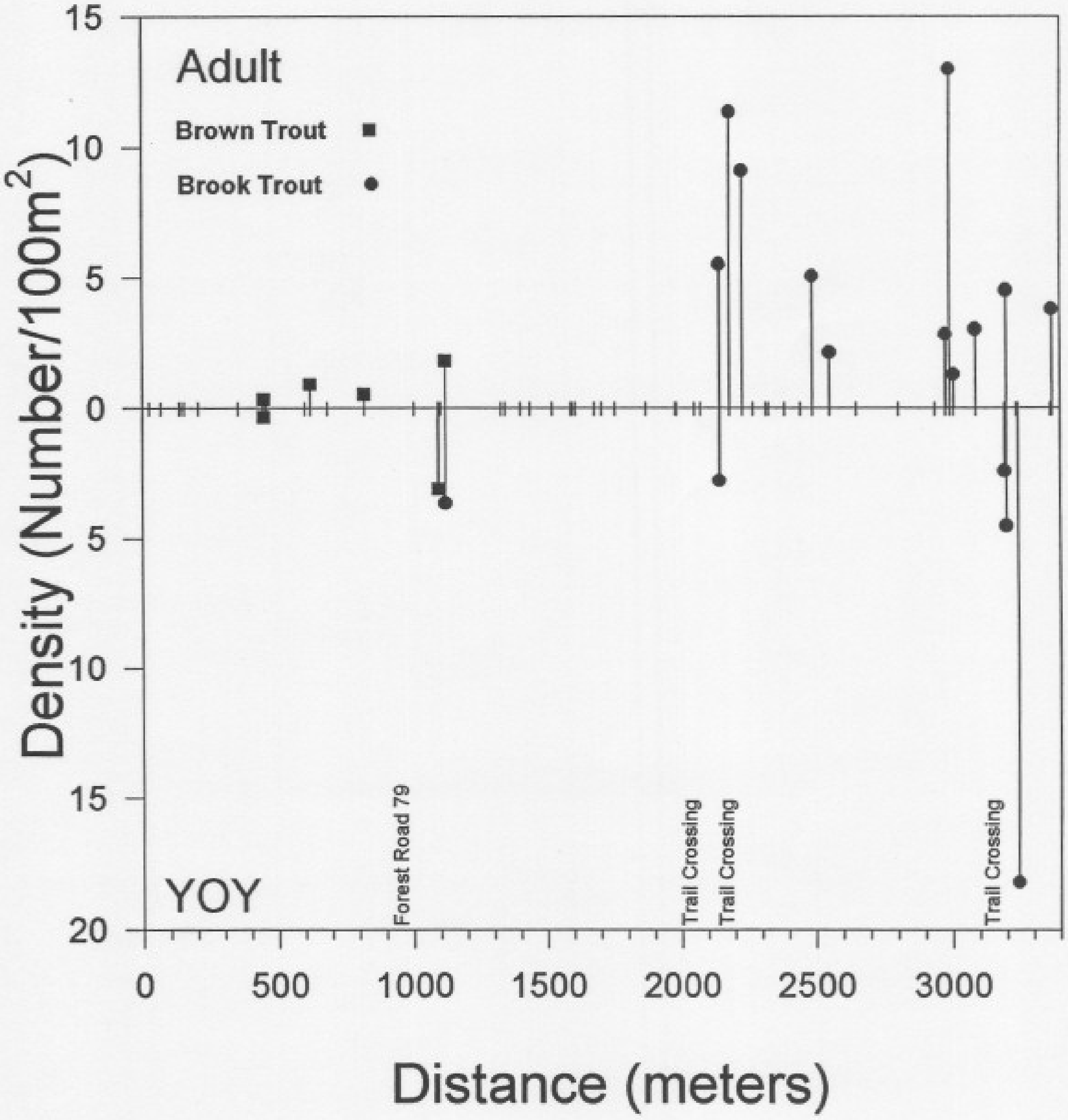


Total LWD
N = 1523
Rootwads
LWD 5
LWD 6
Pieces of LWD
Distance (m)
35
30
25
20
15
10
5
0
5
10
8
6
4
2
0
2
4
6
0
1000
2000
3000
4000
5000
6000
7000
8000

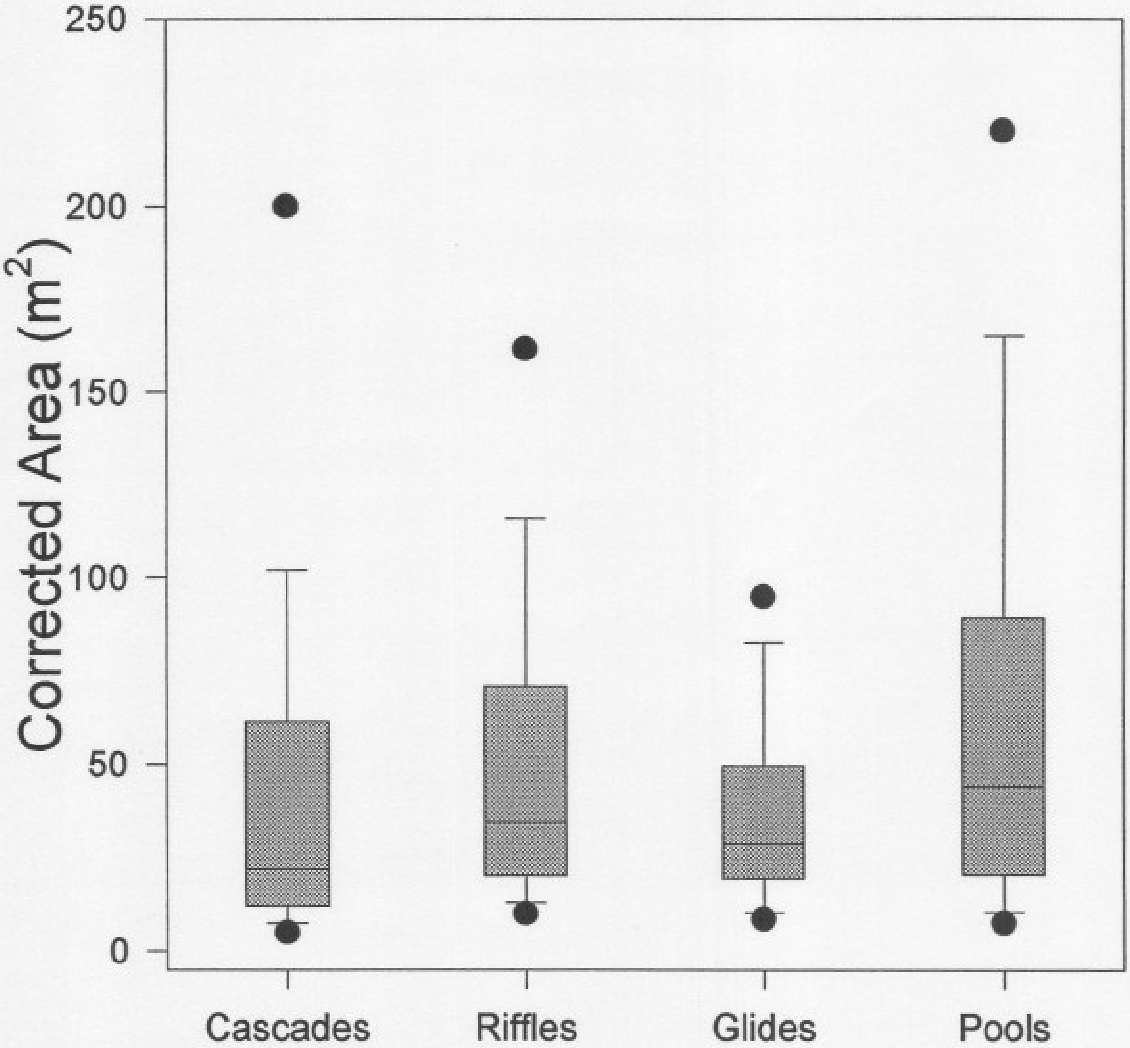
East Fork Overflow



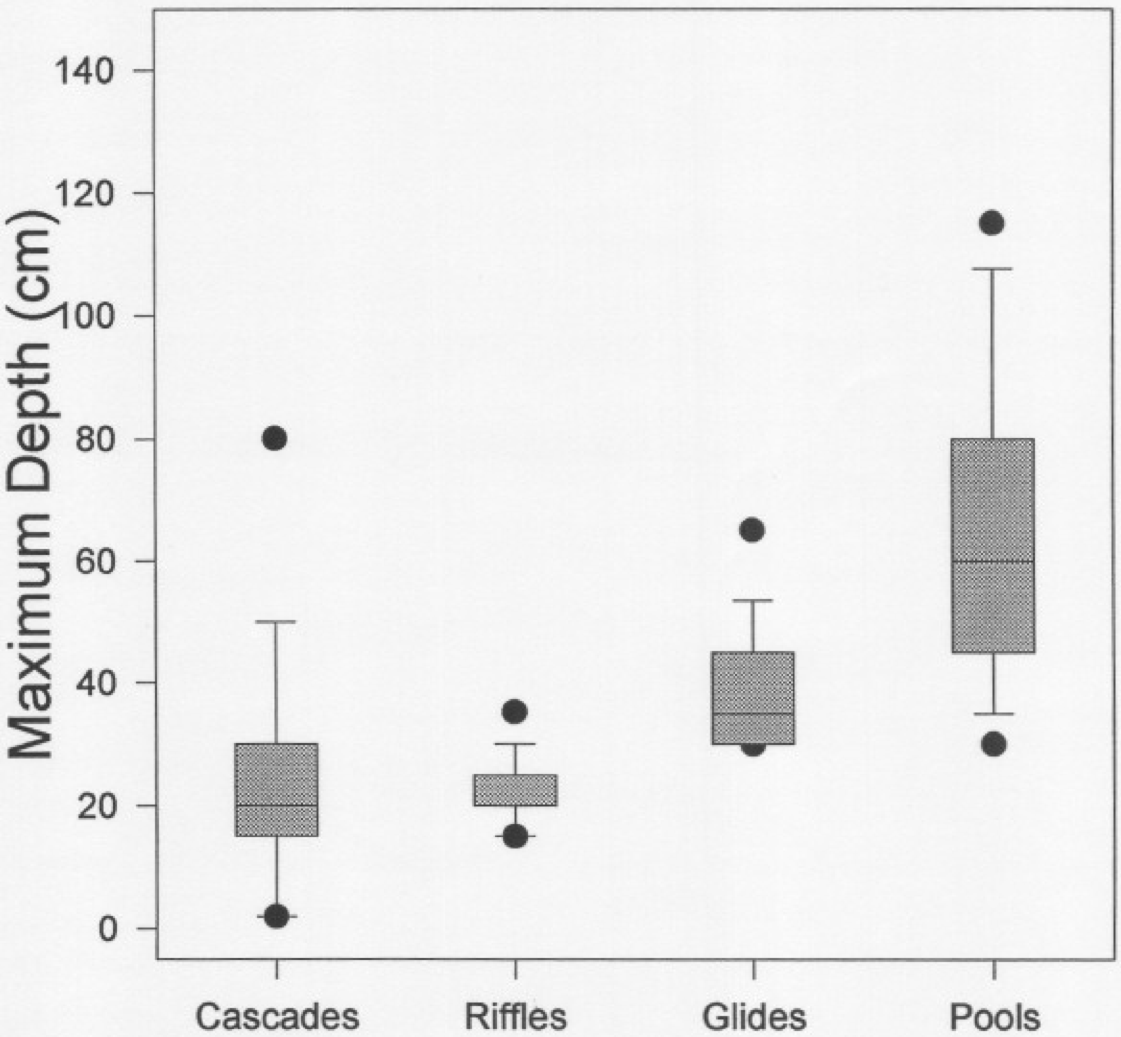
East Fork Overflow



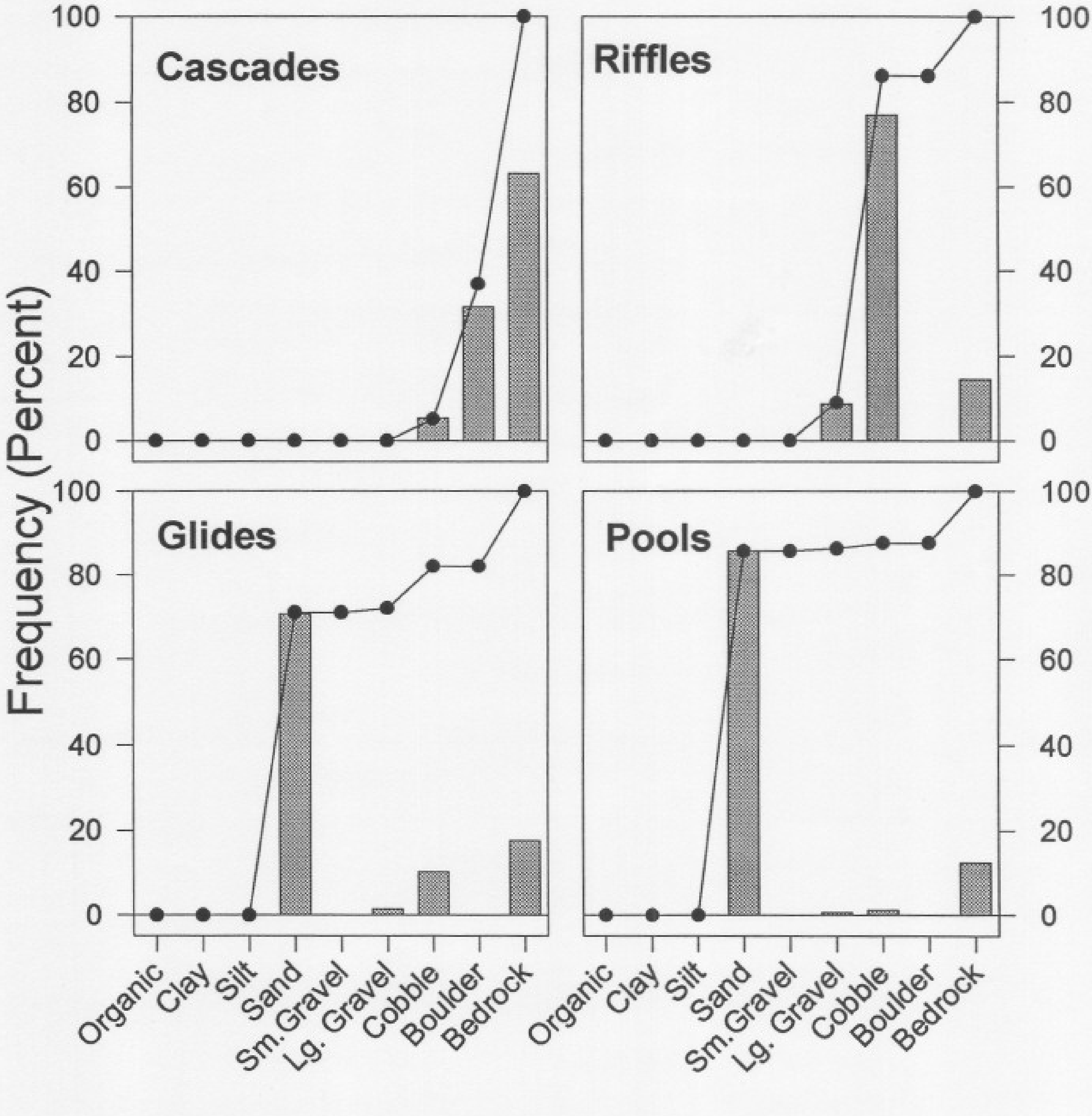
East Fork Overflow



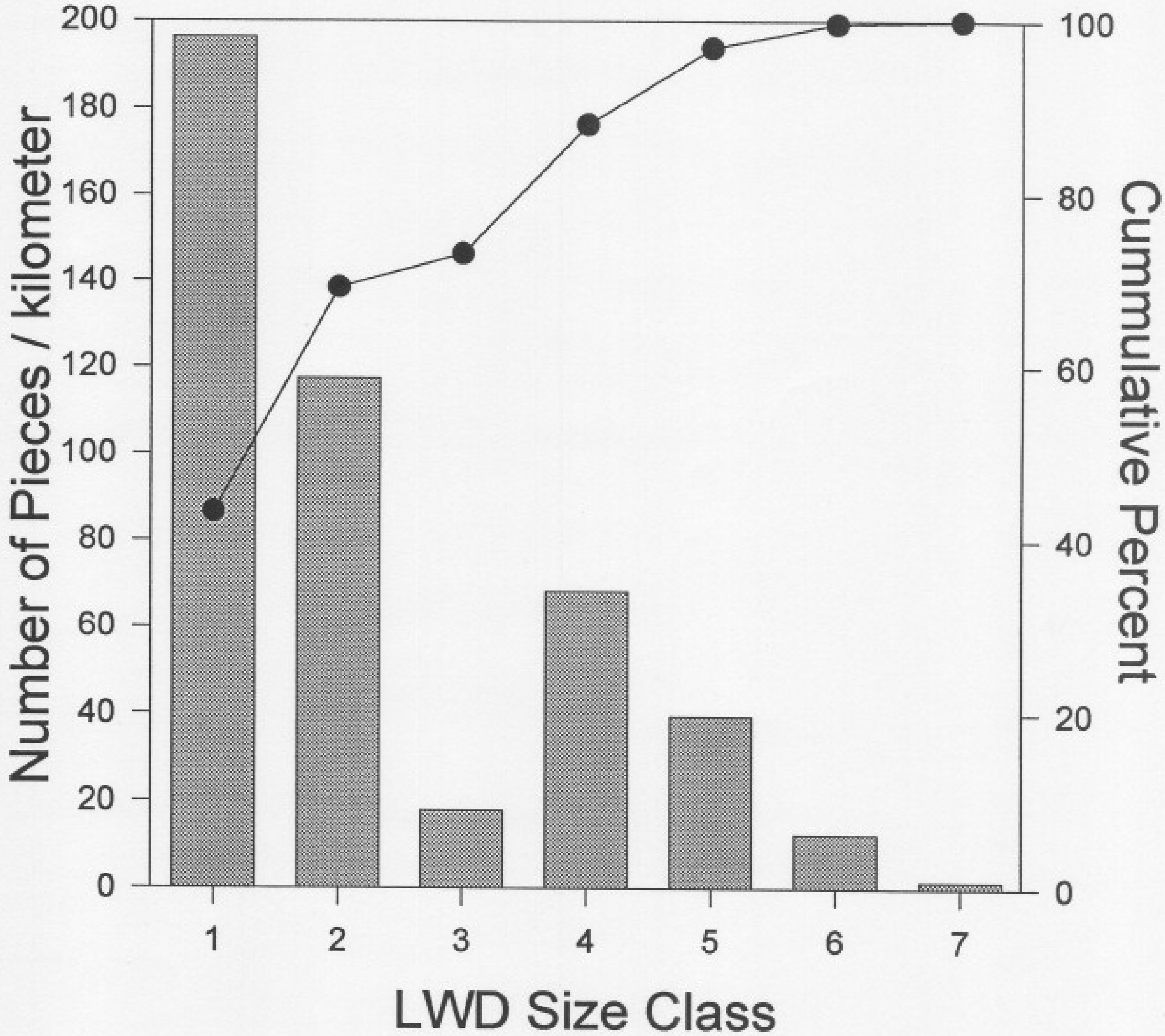
East Fork Overflow



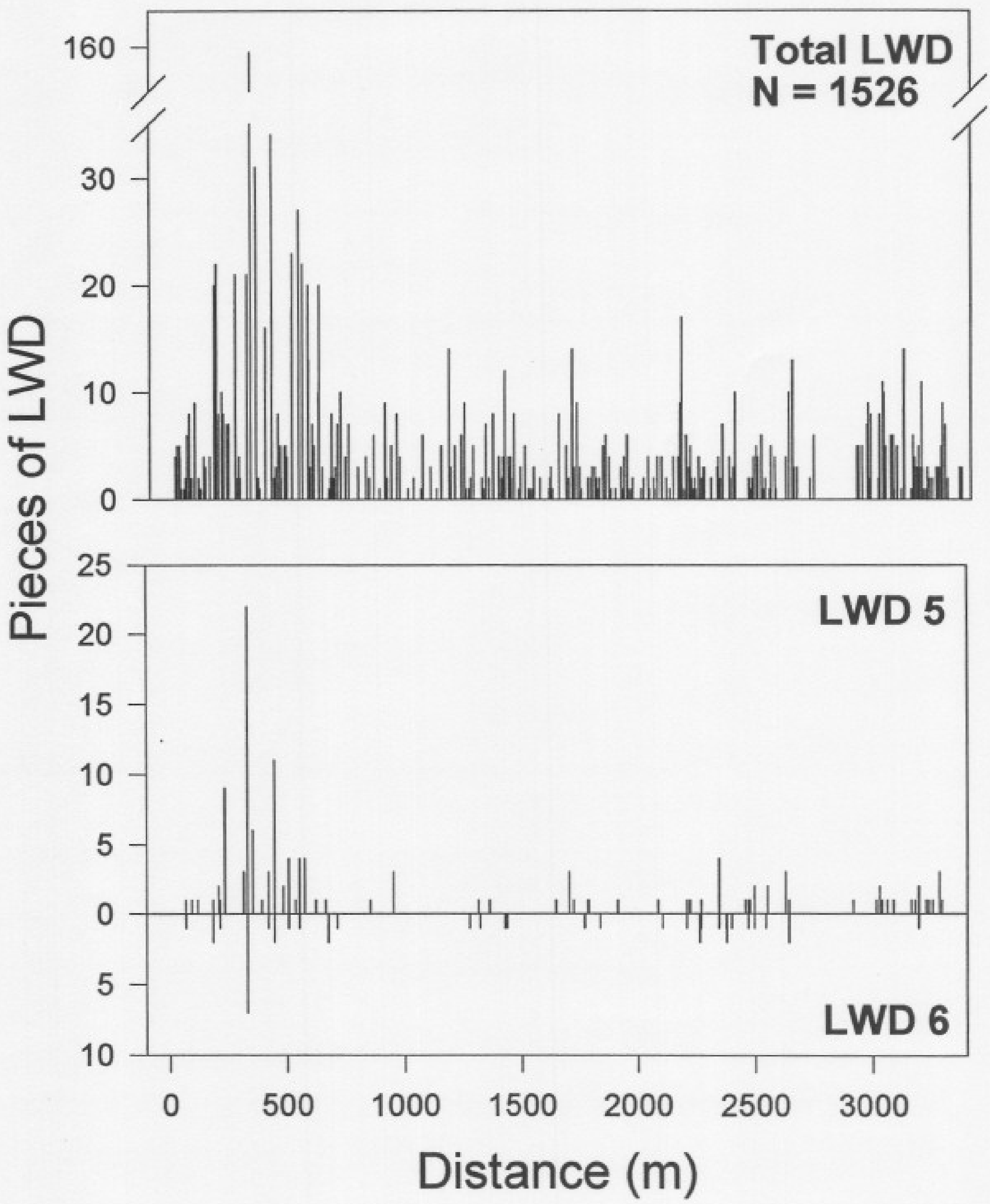
East Fork Overflow



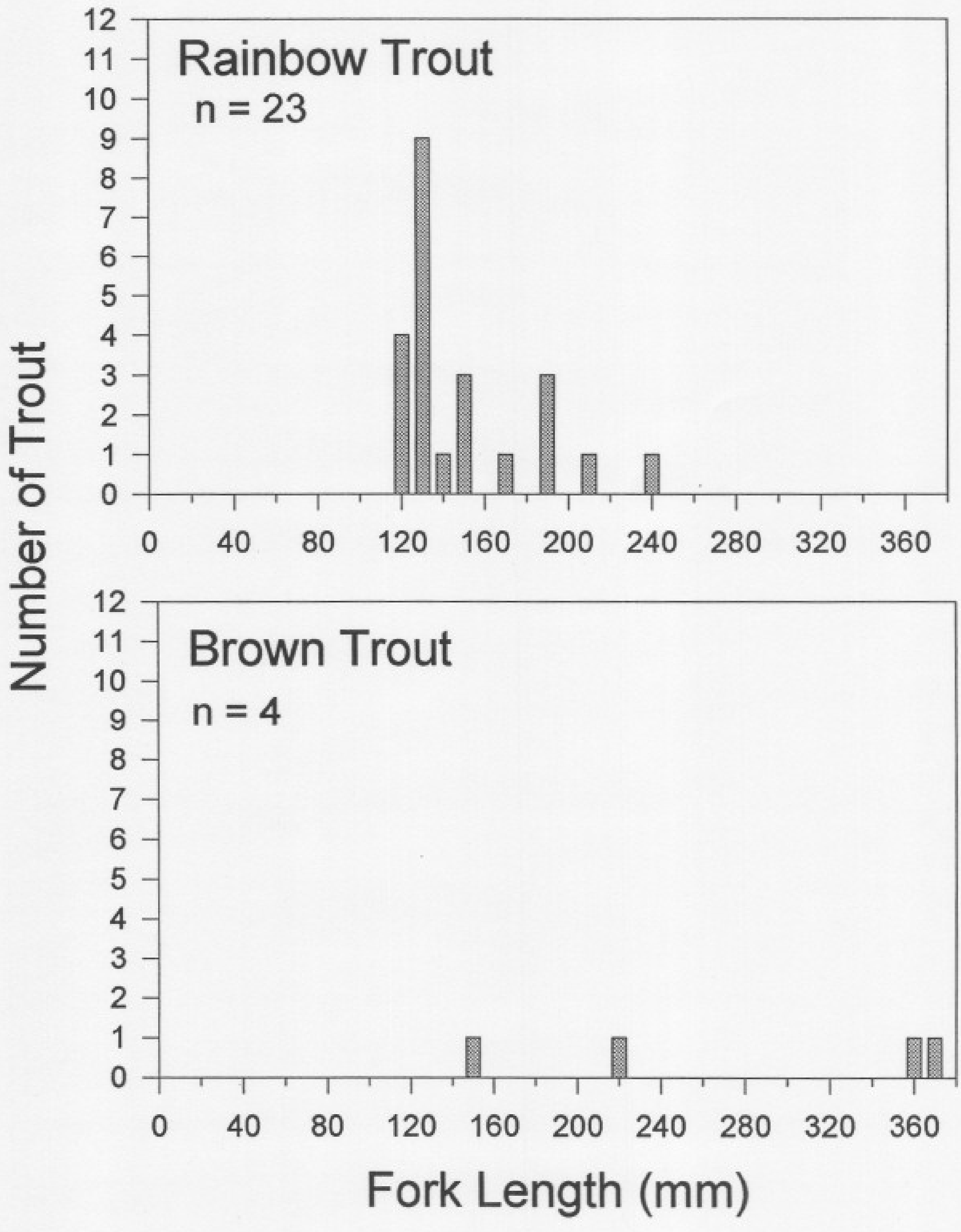
East Fork Overflow



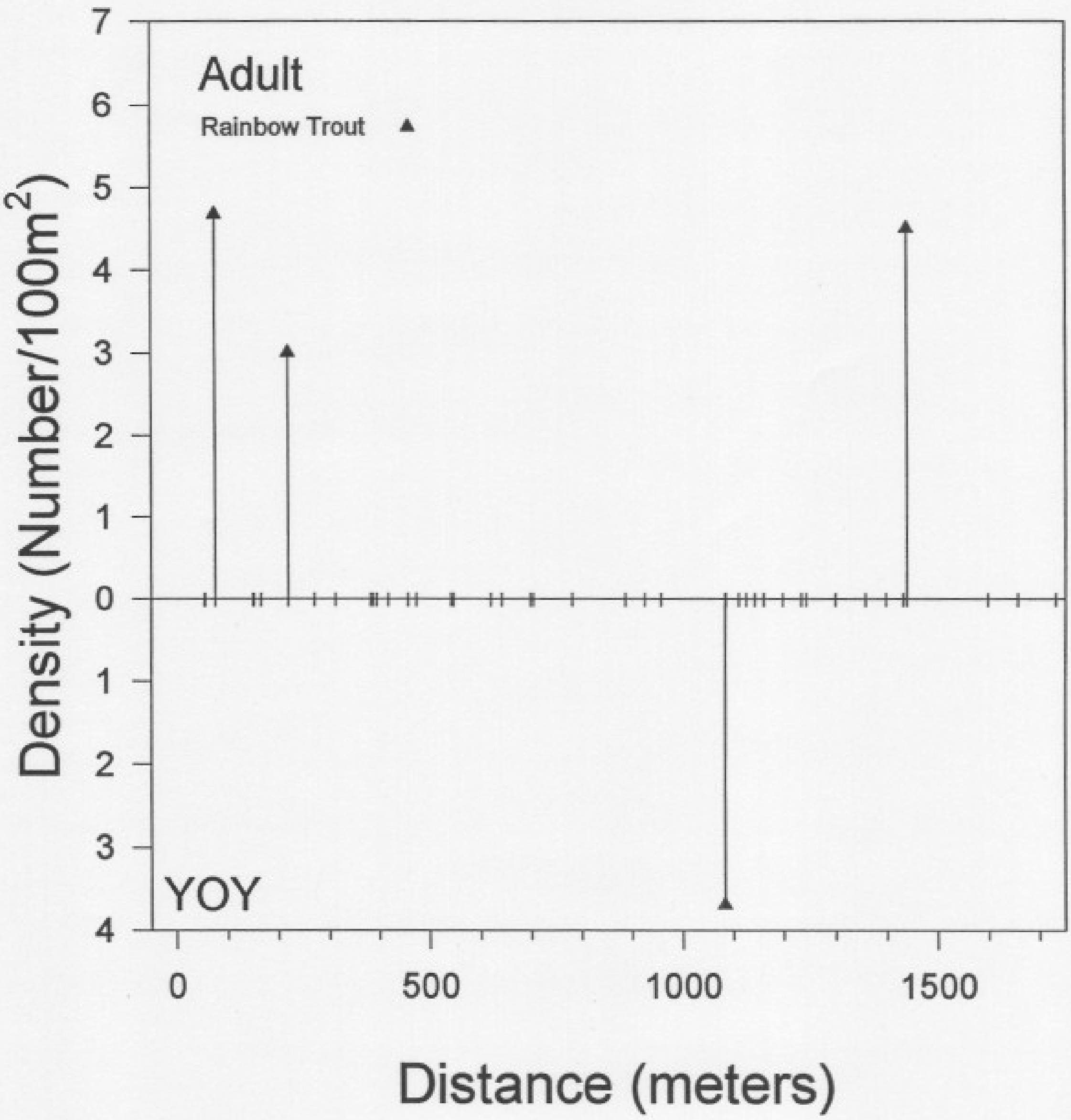
East Fork Overflow



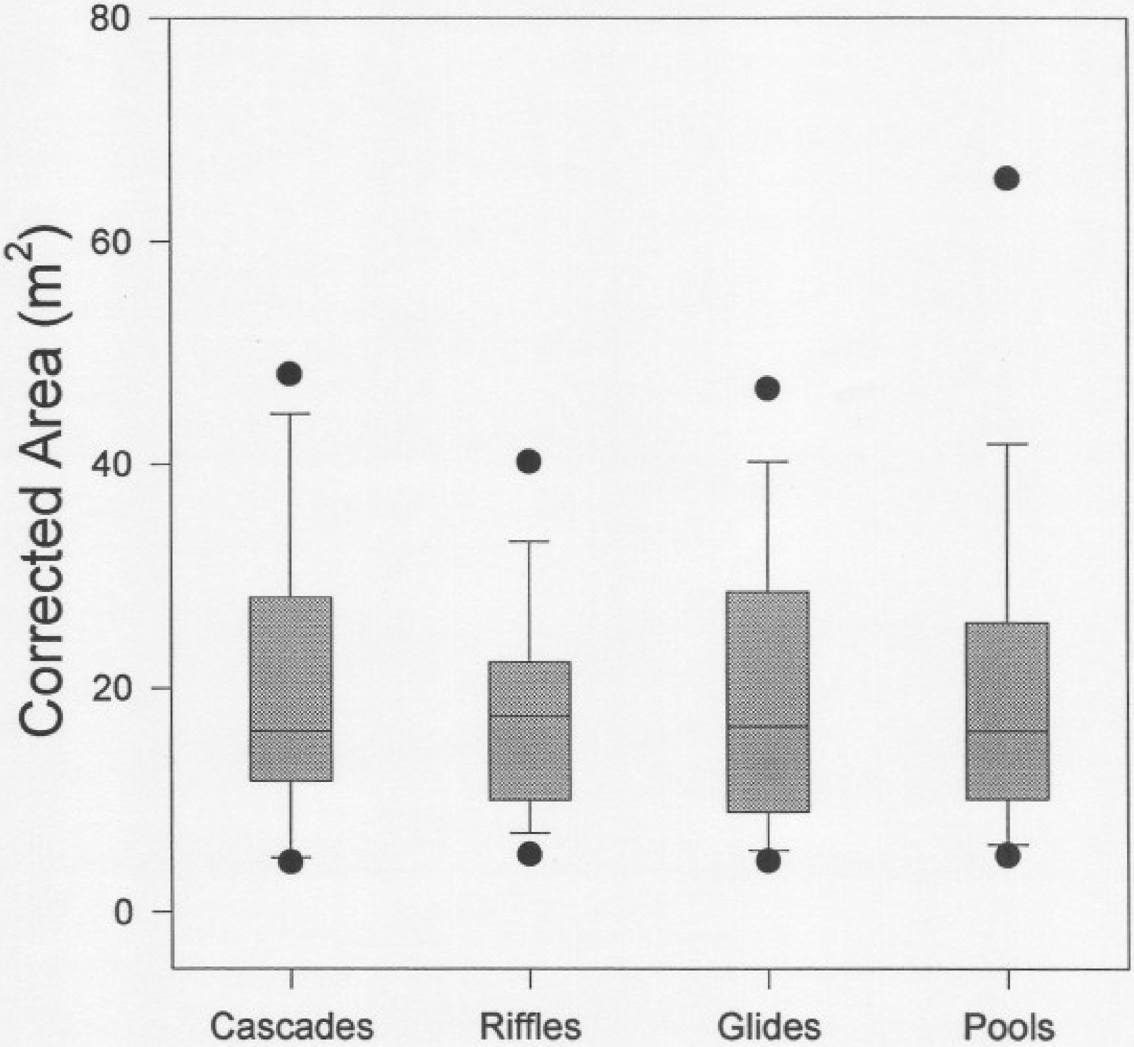
Abes


Rainbow Trout
n = 23
Brown Trout
n = 4
Number of Trout
Fork Length (mm)
0
40
80
120
160
200
240
280
320
360
0
1
2
3
4
5
6
7
8
9
10
11
12

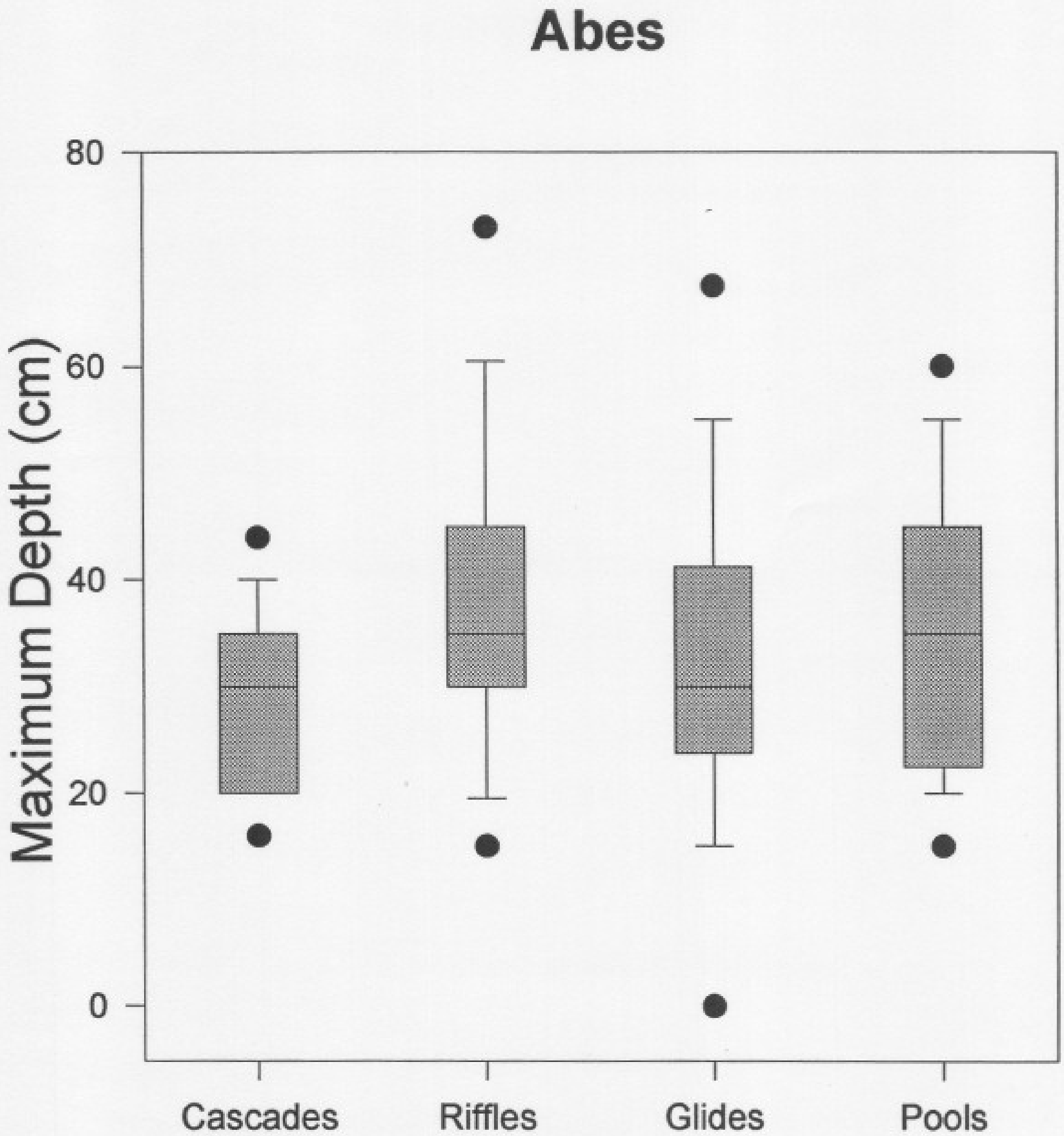
Abes


Adult
Rainbow Trout
YOY
Density (Number/100m²)
Distance (meters)
0
1
2
3
4
5
6
7
500
1000
1500

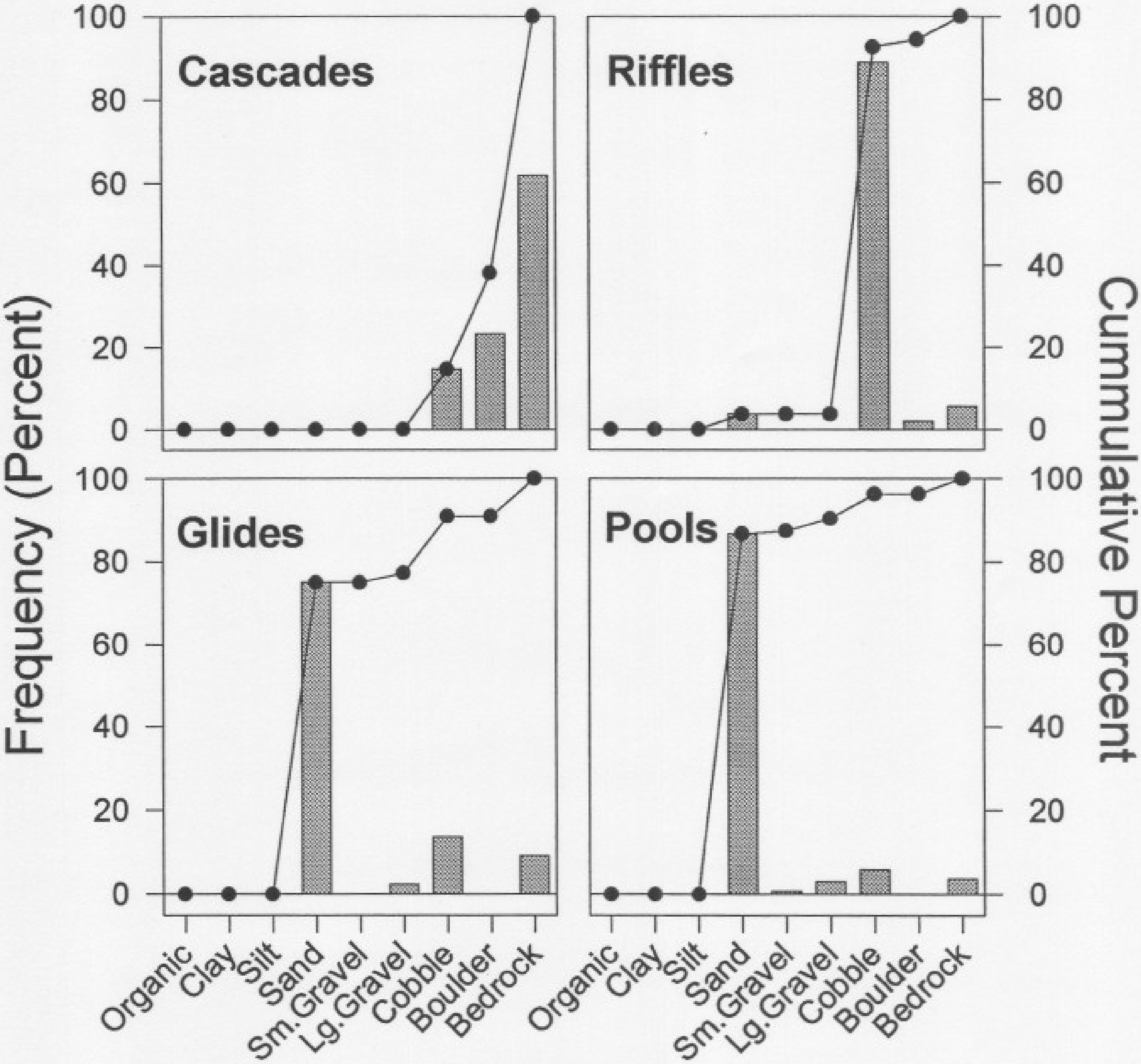
Abes



80
60
40
20
0
Corrected Area (m^2)
Cascades
Riffles
Glides
Pools

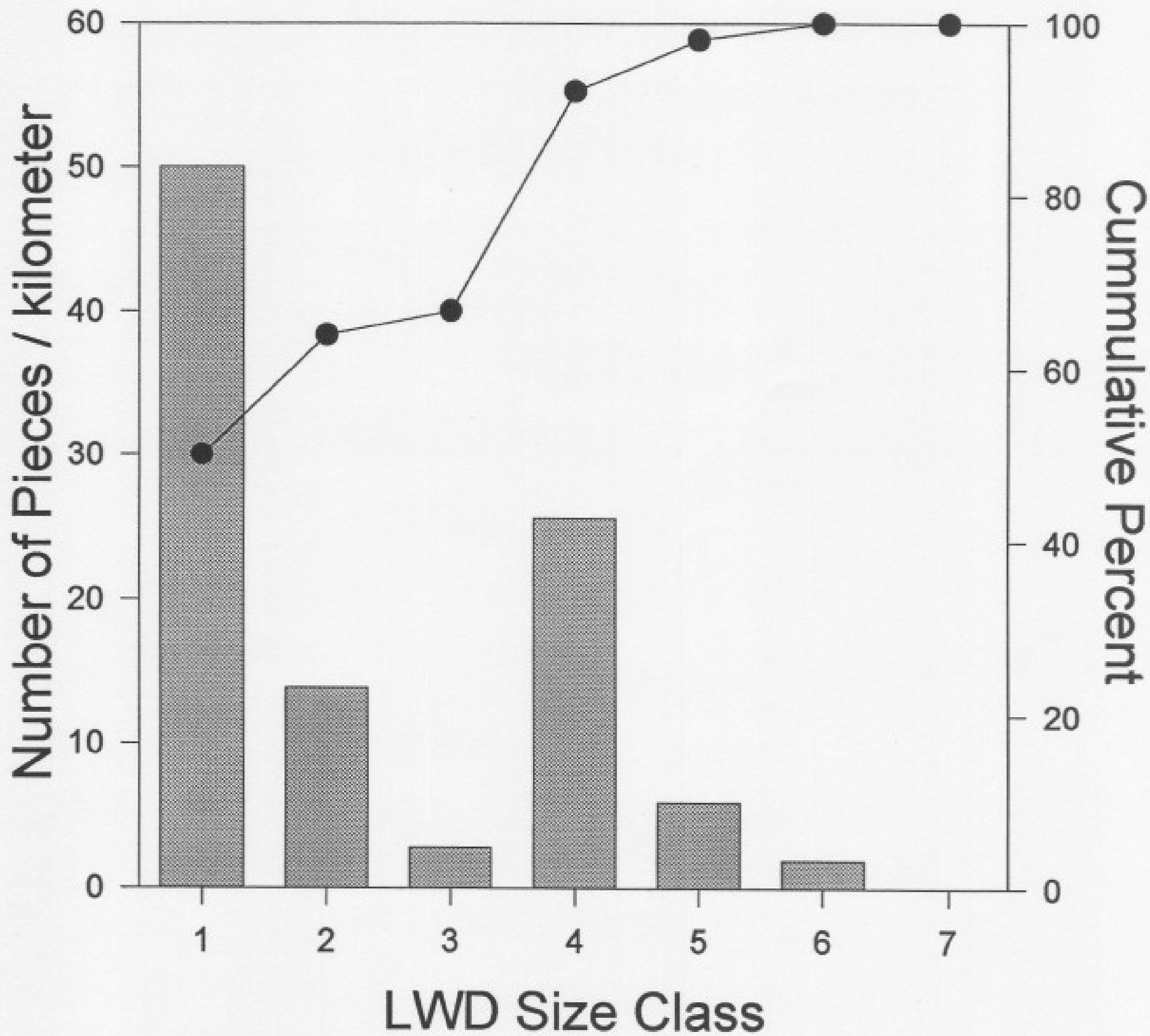

Abes
Maximum Depth (cm)
80
60
40
20
0
Cascades
Riffles
Glides
Pools

Abes



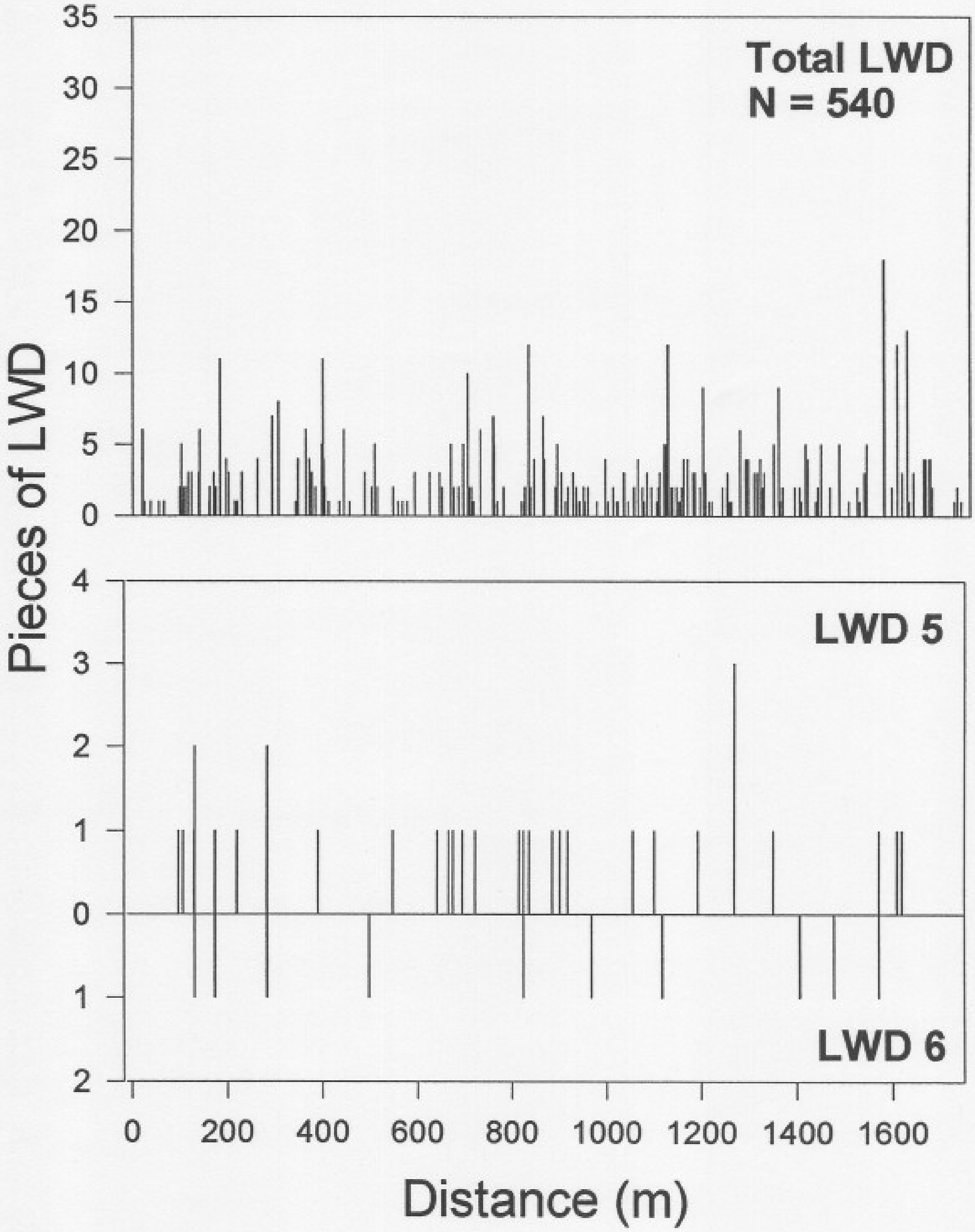
Cascades
Riffles
Glides
Pools
Frequency (Percent)
Cummulative Percent
0
20
40
60
80
100
Organic
Clay
Silt
Sand
Sm.Gravel
Lg.Gravel
Cobble
Boulder
Bedrock

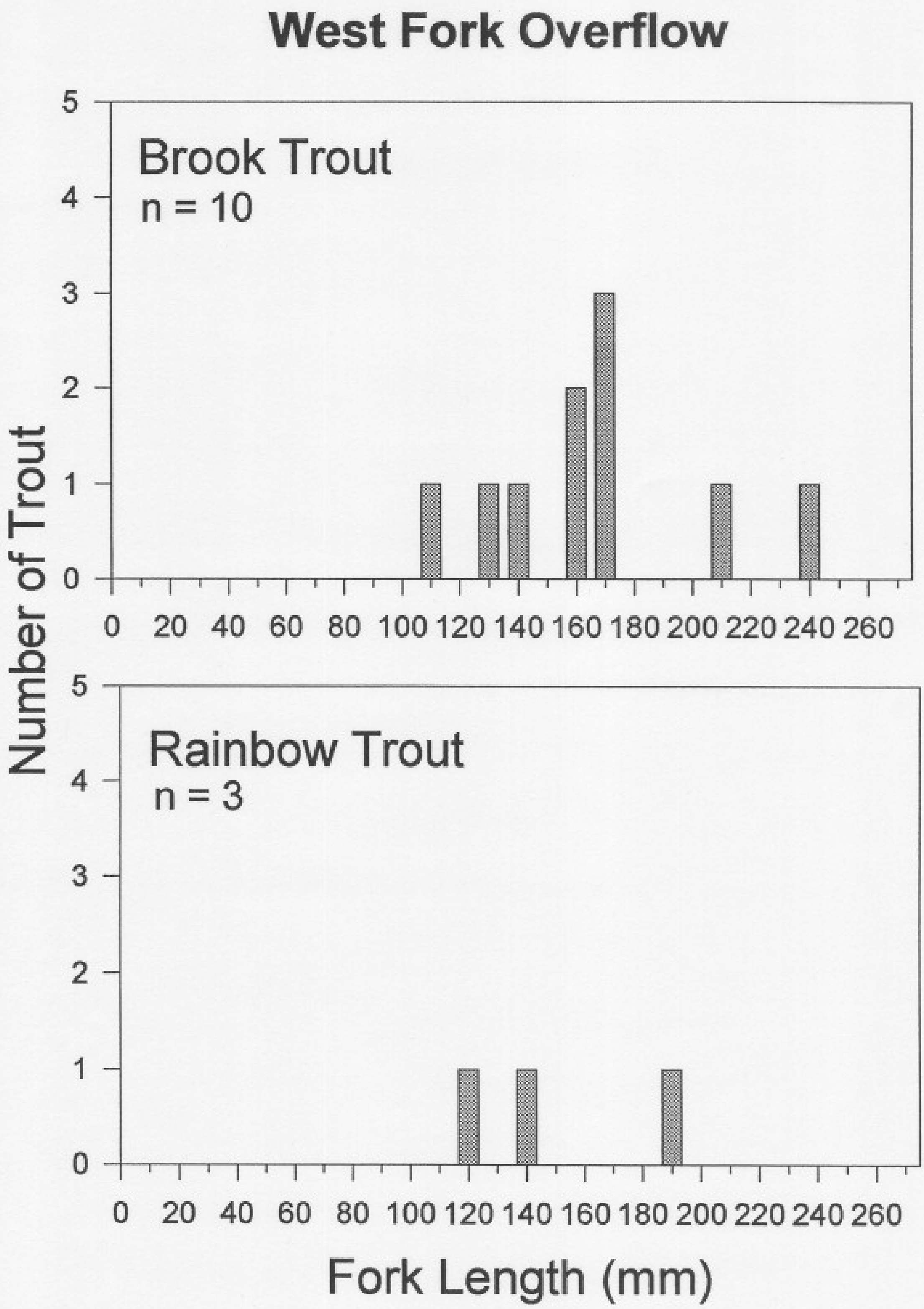
Abes



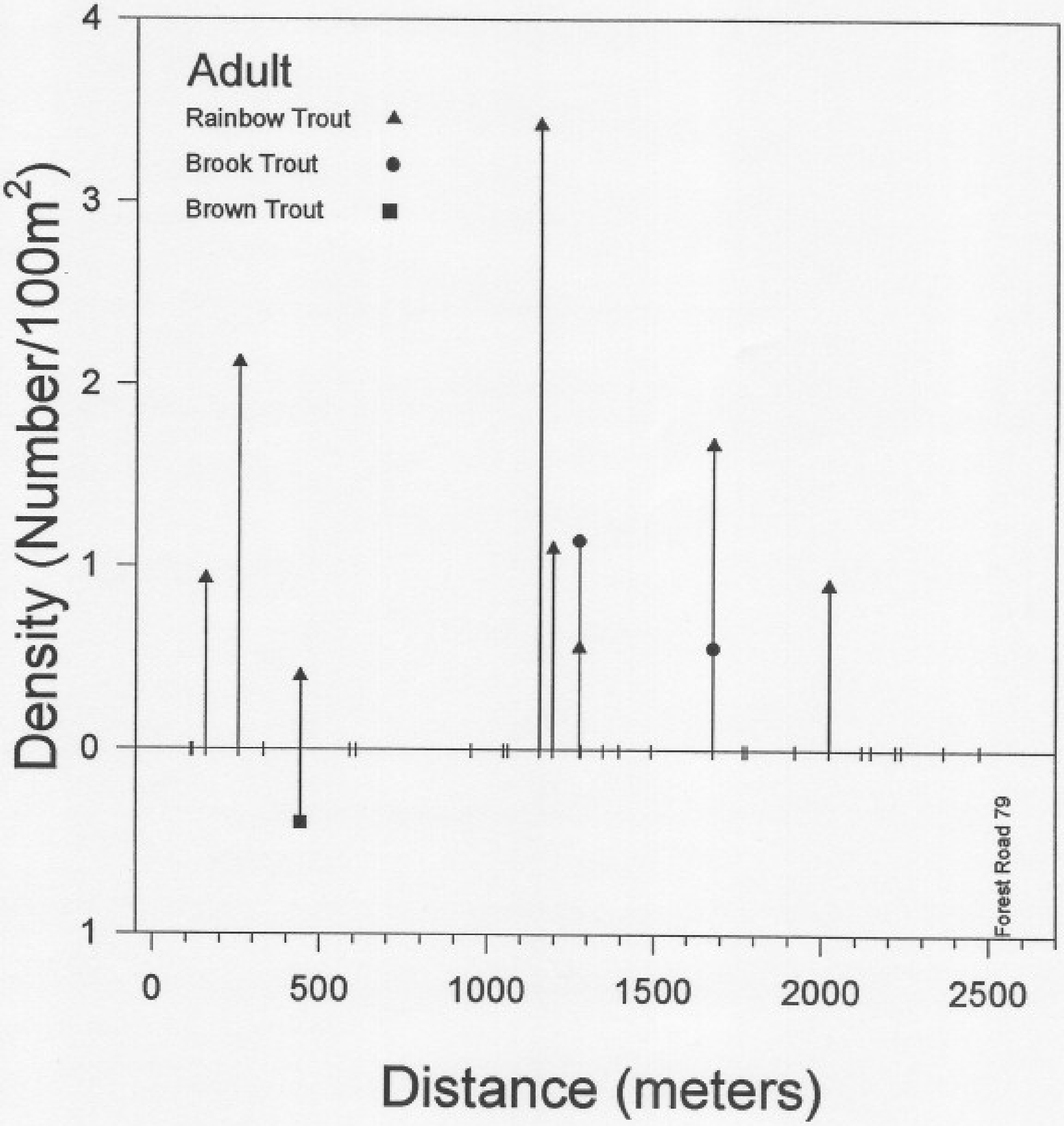
60
50
40
30
20
10
0
Number of Pieces / kilometer
100
80
60
40
20
0
Cummulative Percent
1
2
3
4
5
6
7
LWD Size Class

Abes

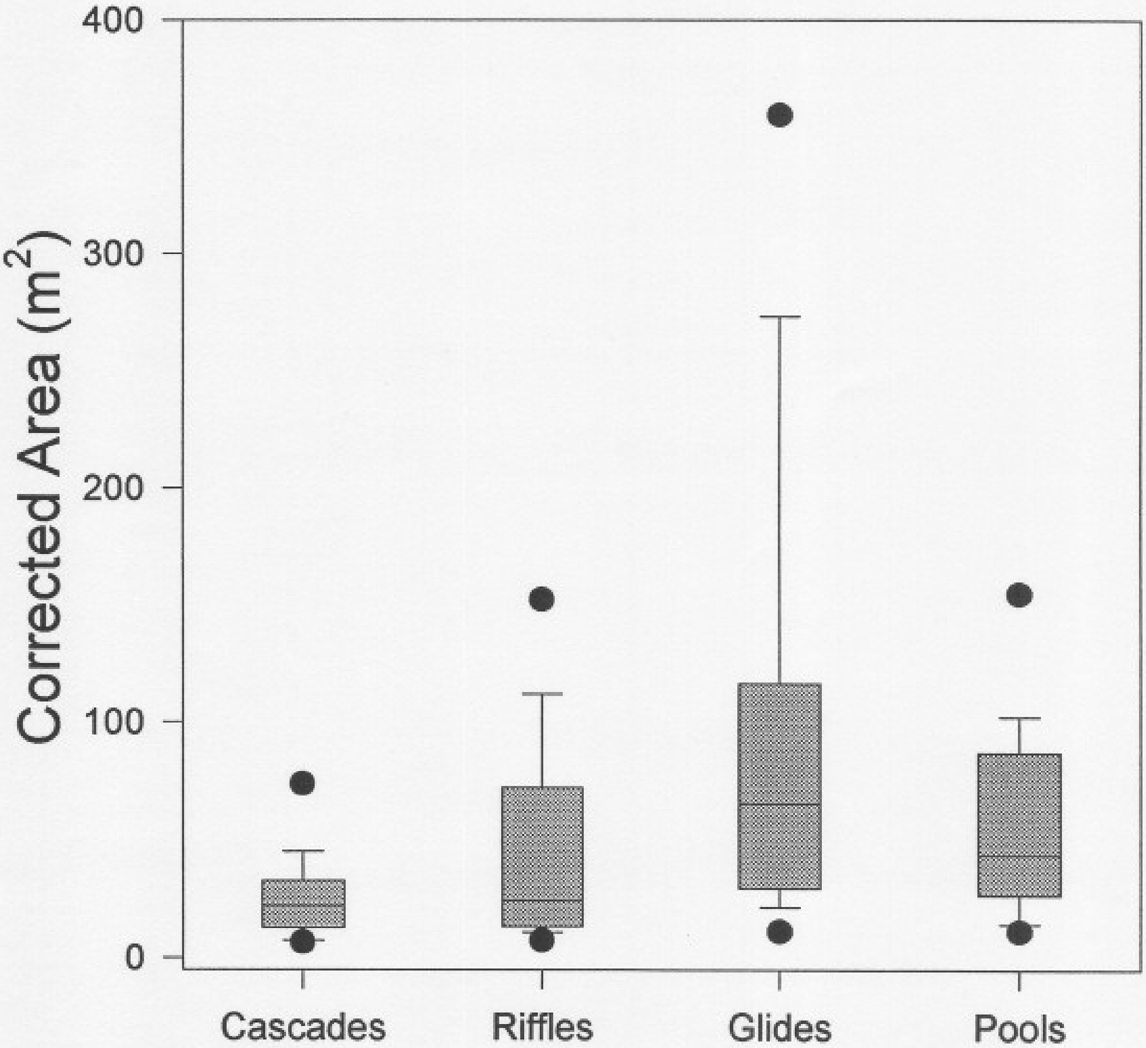

Total LWD
N = 540
LWD 5
LWD 6
Pieces of LWD
Distance (m)
35
30
25
20
15
10
5
0
4
3
2
1
0
1
2
0
200
400
600
800
1000
1200
1400
1600

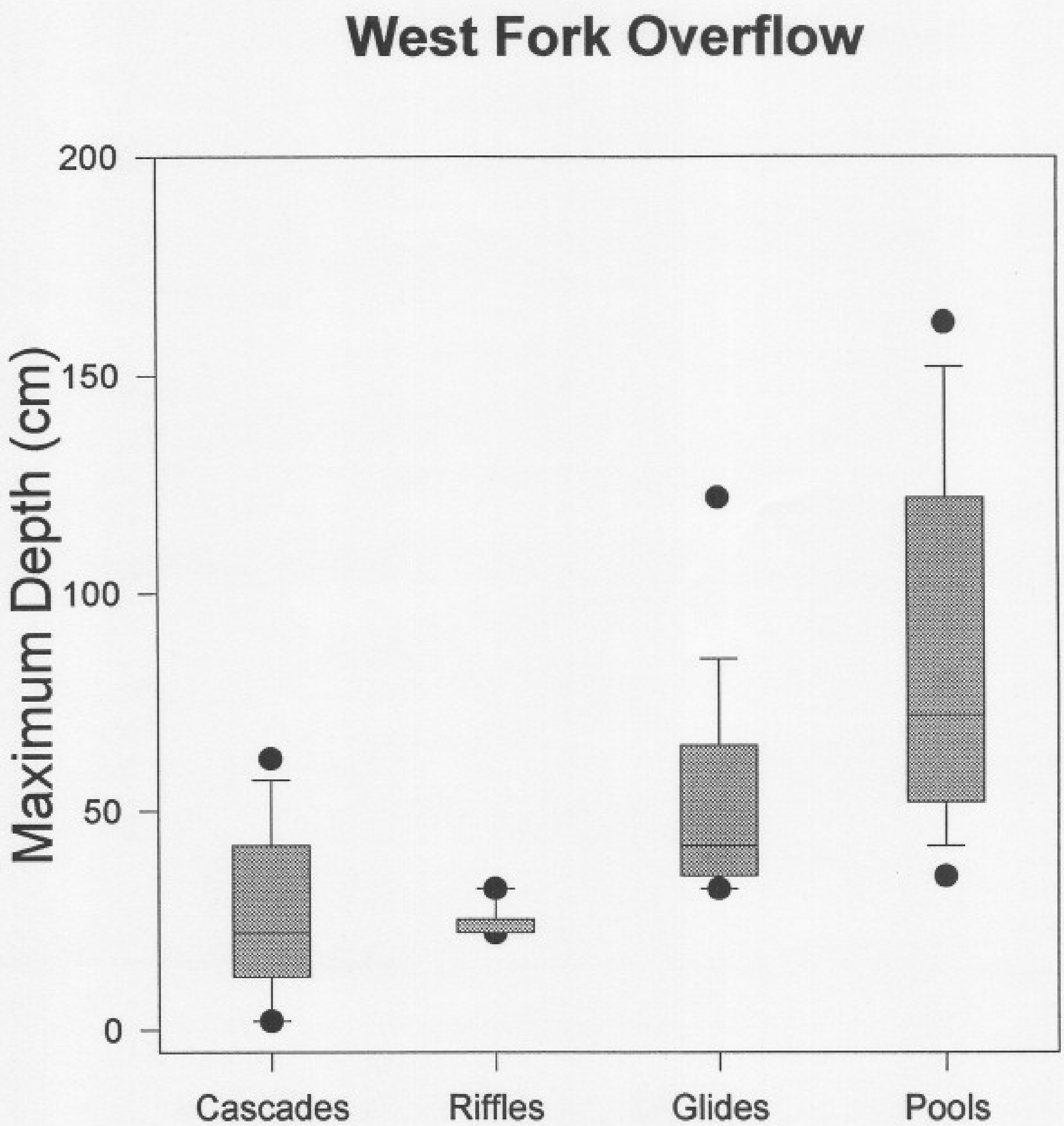

West Fork Overflow
Brook Trout
n = 10
Rainbow Trout
n = 3
Number of Trout
Fork Length (mm)
0
1
2
3
4
5
0 20 40 60 80 100 120 140 160 180 200 220 240 260

West Fork Overflow



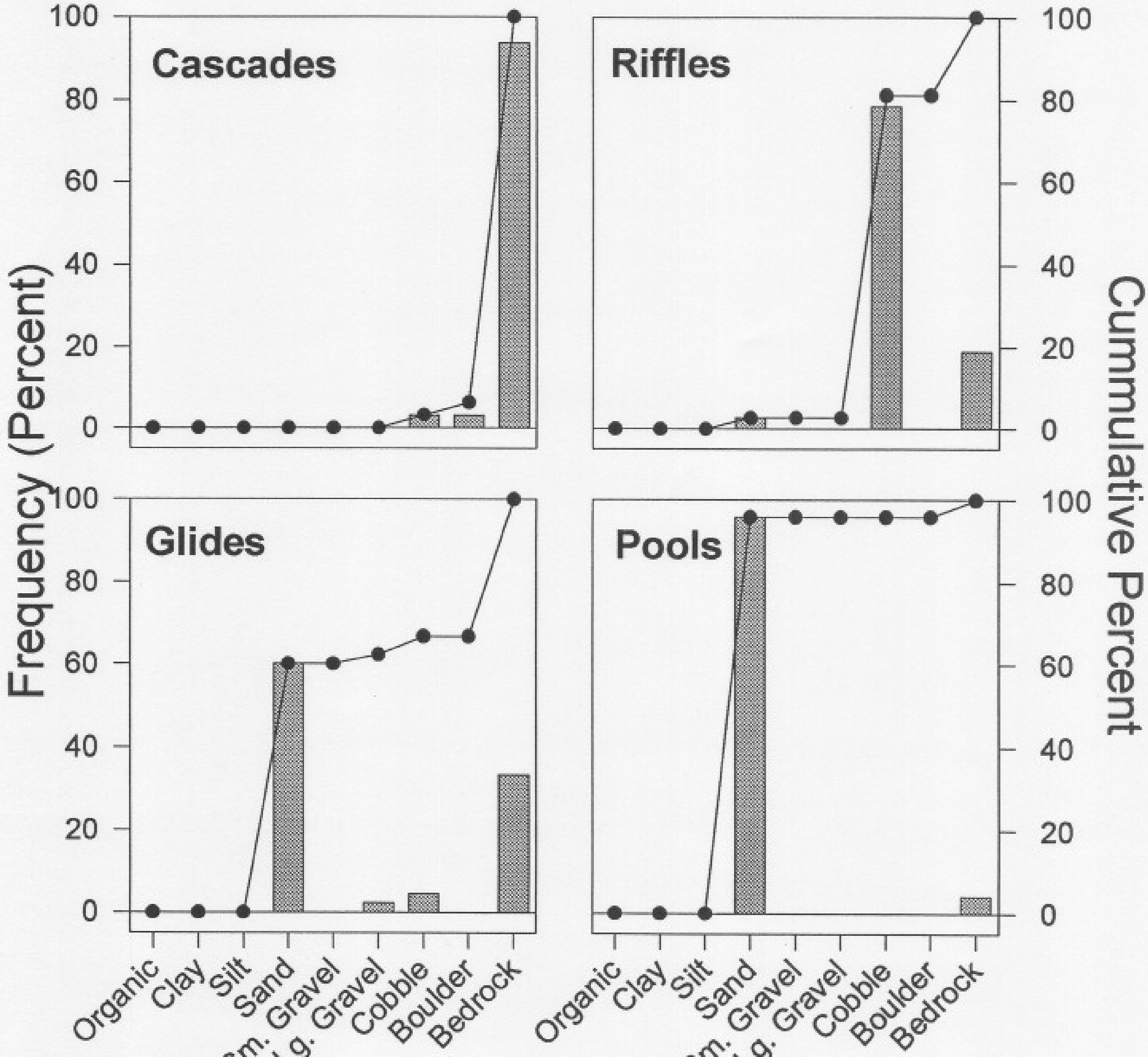
West Fork Overflow

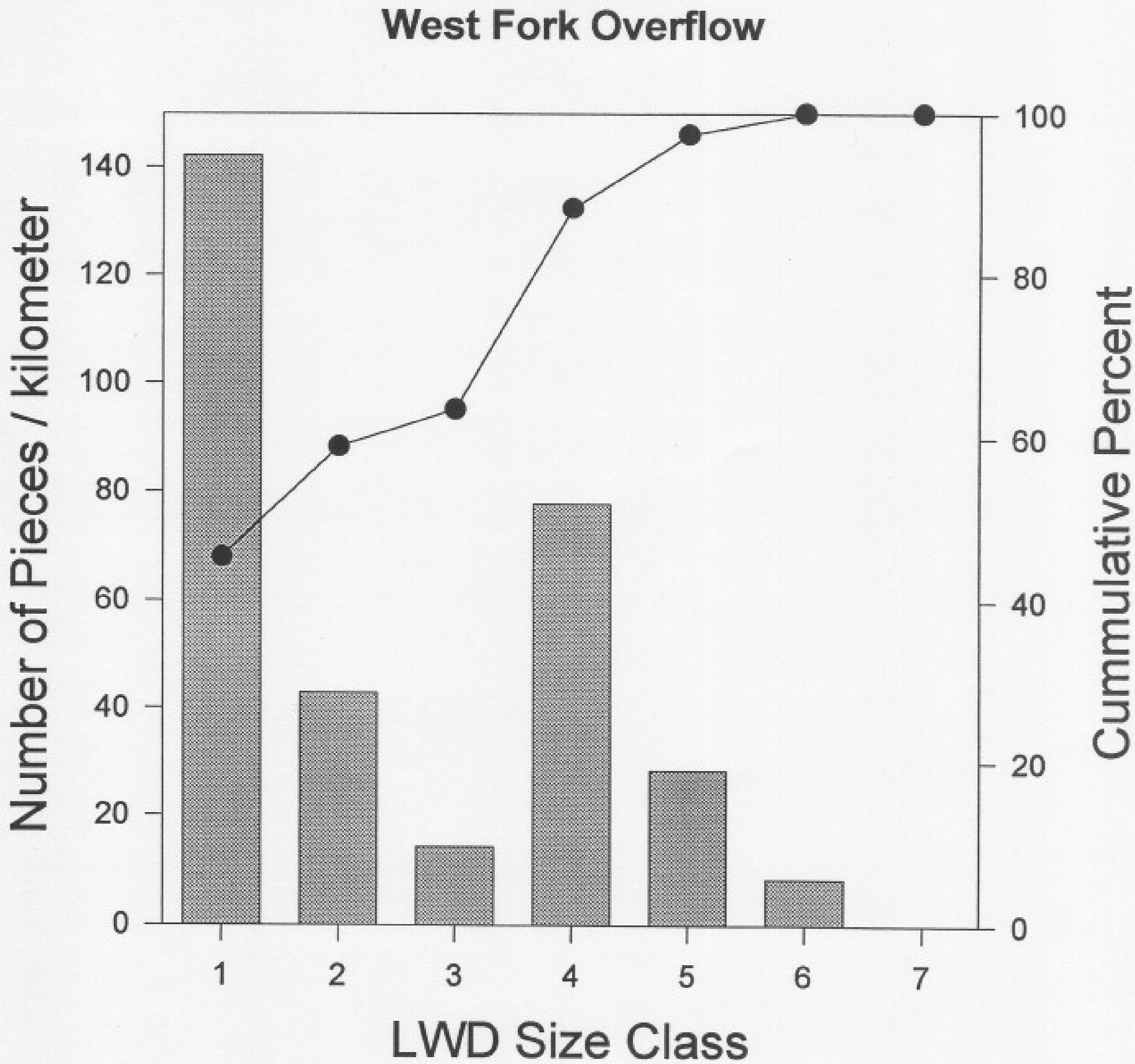




West Fork Overflow
Maximum Depth (cm)
200
150
100
50
0
Cascades
Riffles
Glides
Pools

West Fork Overflow




West Fork Overflow
Number of Pieces / kilometer
Cummulative Percent
LWD Size Class
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7

West Fork Overflow